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EVALUATION OF HORIZONTAL ALIGNMENT DESIGN CONSISTENCY FOR TWO – LANE RURAL HIGHWAY: A CASE STUDY ALONG SHASHEMENE - WOLAYTA SODO AND SHASHEMENE - ASELA ROAD SEGMENTS.

MASTER OF SCIENCE IN CIVIL ENGINEERING

SPECIALIZATION IN ROAD AND TRANSPORTATION ENGINEERING

BY

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HAWASSA UNIVERSITY, HAWASSA ETHIOPIA

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This is to certify that the thesis entitled **EVALUATION OF HORIZONTAL ALIGNMENT DESIGN CONSISTENCY FOR TWO - LANE RURAL HIGHWAY: A CASE STUDY ALONG SHASHEMENE –WOLAYTA SODO AND SHASHEMENE -ASELA ROAD SEGMENTS"** submitted in partial fulfillment of the requirements for the degree of Masters of Science with specialization in Road and Transport Engineering, the Graduate Program of the School of Civil Engineering, and has been carried out by Alemayehu Ayele, under my supervision. Therefore, I recommend that the student has fulfilled the requirements and hence, hereby can submit the thesis to the school.

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We, the undersigned, members of the Board of Examiners of the final defense by Alemayehu Ayele, have read and evaluate his thesis entitled " **EVALUATION OF HORIZONTAL ALIGNMENT DESIGN CONSISTENCY FOR TWO- LANE RURAL HIGHWAY: A CASE STUDY ALONG SHASHEMENE – WOLAYTA SODO AND SHASHEMENE – ASELA ROAD**, and examined the candidate. This is, therefore, to certify that the thesis has been accepted in partial fulfillment of the requirement for the Degree of **Master of Science in civil Engineering (Road and Transport Engineering).**

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I certify that this study entitled **"EVALUATION OF HORIZONTAL ALIGNMENT DESIGN CONSISTENCY FOR TWO-LANE RURAL HIGHWAY: A CASE STUDY ALONG SHASHEMENE- WOLAYTA SODO AND SHASHEMENE ASELA ROAD SEGMENTS"** is my own work. The work has not been presented elsewhere for assessment and award of any degree or diploma. Where material has been used from other sources it has been properly acknowledged and/or referred.

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ABSTRACT

Design consistency is the conformance of highway's geometric and operational features with driver's expectancy. Techniques to evaluate consistency of a design are change in operating speed and change of vehicle stability along the horizontal alignment. To use operating speed and vehicle stability as the consistency tools requires the ability to accurately predict speed as a function of the horizontal roadway geometry. The current Ethiopian road Authority geometric design manual is based on design speed. However, due to the constraints resulting from roadway elements, right of way, and environmental features, inconsistency in operating speed based and vehicle stability based cannot be guaranteed. In order to make informed decisions to ensure highway geometric design consistency, the consistency evaluation of horizontal geometric design of operating speed and vehicle stability on simple curve and tangent section was studied. Forty five sections for both of horizontal curve and tangent section were selected from Shashemene to Wolayta Sodo and Shashemene to Asela. Roadway geometric design variables were obtained from design documents and through field measurements. The speeds of passenger cars, buses, and trucks were measured on each curve and its approaching tangent, under dry day time condition. This study focused on two major issues, in evaluating the horizontal geometric design consistency of selected alignments and developing operating speed predicting models for selected section. Therefore, the results obtained from consistency evaluation of change operating speed between simple curve and tangent section shows that twenty sections were in poor conditions, between design speed and operating speed shows that nine section in simple curves and thirty one sections in tangents sections were in poor conditions. Whereas, consistency evaluation between changes of side friction assumed and side friction demanded shows that twenty seven section in horizontal curves were in poor condition. Finally, both two models were found for horizontal curves and tangents. Model found for horizontal curve and tangents were governed by the combination of grade, super elevation and tangent length. This study would provide information about the improvement design manual for the existing level of design inconsistency and to develop guidelines that designers can use to improve the geometric design consistency of roadway features on high-speed of two-lane rural highway road.

Keywords:-design consistency, design speed and operating speed, general linear models and horizontal alignment.

LIST OF ACRONYMS

AASHTO	American Association of State Highway Transportation and Officials
MR/MR	Maximum radius of curvature to minimum radius of curvature
Δf_R	The change between side friction assumed and side friction demanded
ΔDC	Change in degree of circular curvature between successive design elements
ΔV_{85}	Absolute difference of the 85^{th} percentile speed between successive elements
V_{85}	85^{th} percentile speed on a curve and tangent (Km/h)
V_{90}	90^{th} percentile speed on a curve and tangent (km/h)
CRR	Ratio of individual curve radius to average radius
AACRA	Addis Ababa city road authority
DC	Degree of curvature
ERA	Ethiopia Road Authority
AVGR	Average radius of curvature
AVGT	Average tangent length
CCR	curvature change rate
CRR	Ratio of individual curve radius to average radius
GLM	Generalized linear regression method
V_D	design speed
NP	not provide
KPH	Kilometer per hour
I	deflection angle (deg)
LC	Length of circular Curve (m)
RC	Radius of curvature curve (m
f_{RA}	Side friction assumed/supplied
DA	Deflection angle
TL	Tangent length
R^2	Correlation coefficient of determination
MSE	Mean square error
f_{RD}	Side friction demanded

1. INTRODUCTION

1.1 Background

Design consistency implies that the design or geometry of a road does not violate either the expectation of the motorists or the ability of the motorists to guide and control a vehicle in safe manner. Generally, drivers make fewer errors at geometric features that conform to their expectations. An inconsistency in design can be described as a geometric feature or combinati on of features with unusual or extreme characteristics that drivers may drive in an unsafe manner. This situation could to speed errors, inappropriate driving maneuvers and/or an undesirable level of accidents. There is a strong relationship between geometric consistency and safety. One method of improving safety on road ways is ensuring their consistency of the geometric design. Designers are supposed to provide consistent design up to the expectancies of the driver. To develop a consistent design, however, the designer must have a good working knowledge of driver expectancies. "Driver expectancies relates to the observable, measurable features of the driving environment which: increase driver readiness to perform a driving task in a particular manner, and because the driver to continue in the task utilities completed or interrupted."(Glennon and Harwood, 1978).

Evaluating the consistency of geometric design is one of the promising strategies for improving the rural- highway road safety as sections that lack design consistency experience. Kammes et al. (1995a) state the available methods for evaluating consistency are speed based, vehicle stability based, alignment indices based and driver workload based (Pratico and Diunta,2012). Among the available methods, operating speed based approach and vehicle stability based can be reckoned as the most efficient and widely used. This is because speed is a visible of consistency (Bybin et al., 2015). Also, operating speed and variation can be easily observed and measured.

Estimating of operating speed from highway geometric is the first step in the consistency evaluation process. Models are developed by many researchers to quantify the relationship between operating speed and geometry elements. Given the roadway characteristics of a highway alignment feature, operating speed on the feature can be predicted using such models. But, Jacob et al. (2013) reported that models developed in different countries by various researchers vary in their model form, model parameters and the influencing variables. Among the various geometric features, influence of single horizontal curves on operating speed has been a major subject matter of research. Also, most of the models developed are for predicting the operating speed of passenger. Leisch (2001) developed models for predicting operating speed of different classes of vehicles for Indian traffic condition at single horizontal curve and its preceding tangent. The influencing variables identified by them are length of curve, radius of curve and length of tangent. Researchers have developed a number of methods to evaluate design consistency of road alignments.

Researchers have developed a number of methods to evaluate design consistency of road alignments. In this study operating speed method and vehicle stability method based consistency measures have been used to evaluate the deign consistency of the road alignment and to produce V_{85}^{th} operating speed linear regression model.

1.2 Statement of the Problem

The goal of transportation is generally stated as the safe and efficient movement of people and good. To achieve this goal, designers use many tool and techniques. One technique used to improve safety on roadways is to examine the consistency of the design. Design consistency refers to highway geometry′s conformance to driver expectancy. Generally, drivers make fewer errors in the vicinity of geometric features that conform to their expectations than at features that violate their expectation(Alexander & Lunenfeld, 1986).

In Ethiopia design manual, design consistency on two-lane rural highway road has been assumed to be provided through the selection and application of a uniform design speed among the individual alignment elements. Geometric design inconsistencies related with speeds on highways are causes of major traffic accidents. Apart from this, it is known that in some part of the road alignments the drivers are using higher speeds than design speed.

The present design practice in Ethiopia design manual do not consider the ergonomic element in of the human factor for roadway design since approach for design speed concept only applies to horizontal and vertical curves independently and also do not take into consideration the tangents between these curves in an integrated manner. Considering sources of design inconsistency in current geometric design practice, the impact of inconsistencies of existing alignments on road safety must be investigated.

The convectional approach of design in Ethiopian Road Authority does not provide any guidance in determining the maximum tangent length. Therefore, the highway designers are not able to control the maximum operating speed on tangent since longer tangents encourage higher operating speed and drivers may after to reduce their speeds significantly or make abrupt changes when they are approaching a sharp curve after driving a long straight road segment. Note that highway in rural areas of the country are generally designed to give road users both accessibility and mobility. There is no in depth investigation being reported on the model of the 85^{th} percentile operating speed for horizontal alignment on two-lane rural highways in Ethiopia. This research is will be useful in designing or redesigning the horizontal alignment especially for two-lane rural highways where the highways convey high traffic speed. Therefore, this research proposes a model for evaluating the speed of 85^{th} percentile operating speed for horizontal on two- lane rural highways with the development of an operating speed model is based on data collected.

The design speed concept is the mechanism for achieving consistency among the individual elements of an alignment. Design speed is the "the maximum safe speed that can be maintained over specific section of highway when conditions are so favorable that the design features of the highway govern" (Alexander & Lunenfeld, 1986). Implementing the design speed concept involves two steps. First, a design speed is selected "Consistent with the speed driver is likely to expect, "on the bases of the functional classification of the highway, development environment, and topography. Then "all of the pertinent features of the highways would-be related to the deign speed to obtain a balance design"(Alexander & Lunenfeld, 1986). The design speed concept presumes that a design will be consisted if the individual geometric features share the same design speed. A fundamental limitation is that the design speed applies only to horizontal and vertical curves, not to the tangents that connect those curves. Design speed has no practical meaning on horizontal tangents. It provides no basis for establishing maximum tangent lengths to promote consistency by controlling the maximum operating speeds that can be attained. Design speed concept does not provide sufficient co-ordination among individual geometric features (grades, radius, curve length, super elevation etc.) to ensure consistency. It controls only the minimum value of the maximum safe speeds for the individual features along an alignment. Consequently, the design-speed concept currently used in Ethiopia does not explicitly consider the speeds that motorists are operating.

Due to these situations drivers are using higher speeds than specified on the design and these situations are causing accidents to human live and properties. This thesis research was made to evaluate the consistency of horizontal geometric design consistency particularly on simple curves and tangent section using V_{85}^{th} percentile operating speeds and vehicle stability of using the passenger cars, buses and trucks.

1.3 General Objective

1.3.1 Study Objectives

The general objective of this research is to evaluate of horizontal alignment design consistency for two- lane rural highways along Shashemene to Wolayta Sodo and Shashemene to Asela.

1.3.2 Specific Objectives

The Specific objectives of the study are:-

- To evaluate horizontal geometric design consistency on selected segments.
- To develop general linear regression model relating the 85^{th} percentile operating speeds with horizontal geometric elements.

Research Questions

1. How much level of design consistency rate of horizontal alignments?
2. Is it possible to establish the relationship between the 85^{th} percentile operating speeds with the horizontal geometric elements?

1.4 Significance/Contribution of Study

- In the 1970s several factors led to the examination of the role of geometric design standards regarding road safety. These factors include in shifting from using standards for road building to road upgrading and the advances in technology and research .In the 1980s, design by the objectives rather than by standards emerged as a new approach for geometric design. This new a pproach calls on assessment of objectives and one of the most important objectives is safety and this study attempts to assess the current design consistency situation. It is, therefore, hoped and expected to provide insights which have some gap on the current design on the Ethiopia road design manual. Accordingly, this study will contribute or significant information on the following issues.

- ✓ It would provide for Ethiopia Road Authority (ERA) manual has to address the effect of operating speeds on design and safety
- ✓ To develop guidelines that designers can use to improve the geometric design consistency of roadway features on high-speed, non-urban, two-lane roads
- ✓ It would provide insights in an attempt to revise and establish the road design manual directions on the Ethiopia road design manual that will be up to date and efficient for the country under study.
- ✓ It will provide information about the improvement design manual for the existing level of design inconsistency.
- ✓ It helps to stimulate further investigation in the design manual.
- ✓ It will initiate to develop the criteria to evaluate Road design consistency in the county.
- ✓ It can help to ensure that roadway designs are developed that minimize the potential for the driver error.
- ✓ It will be used to identify a section of Road to be maintained or repaired due to design inconsistency.
- ✓ Road Authorities to evaluate their Design manuals problems.
- ✓ To develop guidelines that will help highway designers and decision makers evaluate and select the best alignment alternatives.

1.5 Scope of the Study

The scope of this study was limited to rural two – lane highway horizontal alignments (I.e. Curve to tangent or tangent to curve). Multi- lane highways was not included because inconsistency in the geometric design of these highways does not lead to hazardous conditions similar to those of two- lane rural highway road. Operating speeds of different vehicle classes (Passenger cars, Buses and trucks) was observed only under dry day time condition. Rainy and dusty or foggy weather conditions were not included

2. LITERATURE REVIEW

This chapter provides a review for geometric design consistency and Horizontal curve, and potential measures of geometric design consistency. It also provides a review of some model used for predicting consistency measures and corresponding evaluation criteria.

2.1 Geometric Design Consistency and Horizontal Curve

The notion of using design consistency as the means of evaluation roadway safety is not a novel one. Transportation professionals have long recognized the need to design roadway in consistent manner; however, the manner in which they define "design consistency" has been subject to substantial discrepancy. Design consistency refers to the condition where in the roadway alignment does not violate the expectancy of the driver or impede their ability to guide and control their vehicle in a safe manner but it makes sense intuitively the drivers will make more errors at geometric features that violate expectations than those that conform to their expectation (Glemnon and Hrwood,1978). In order for a design to be considered inconsistent, the inconsistency that exists on a roadway can produce a sudden change in the characteristics of the roadway, which surprise motorists and lead to speed errors. Theses speed errors results in critical driving maneuvers for motorist and unfavorable level of accidents risks. An inconsistency in design can be defined as "a geometric feature or combination of adjacent features that have unexpectedly high driver workload those motorists may be surprised and possibly drive in an unsafe manner" (Fitzpatrick et al., 2002).

Methods of evaluating consistency can be grouped into the following areas:

- Design Consistency: promote uniform vehicular speeds along the roadway, reduce speed variability, or provide the means to an iterative process to enable designers to more closely match predicted operating speeds and design speeds(i.e. Related to the difference between the operating speed, represented by the 85th percentile speed (V_{85}), and the design speed (V_D) of the observed roadway section(Safety criteria I);
- Operating Speed Consistency: related to the difference in V_{85} between two successive geometric elements(Safety criteria II) ;
- Driving dynamic consistency: determined by the difference between side friction assumed (f_{RA}) and demanded (f_{RD}) (Safety criteria III)

- Driver workload: measures are intended to “manage” the workload on the driver so that a more consistent level of effort is required on the part of the driver. Extreme features, unusual features, or combinations of features are examined for their influence on driver workload.

The most significant geometric design element that influences driver behavior and possess the most potential for accident is the horizontal curve. The horizontal curves whose design speed is less than drivers’ desired speed show operating speed inconsistency that increase accident potential .From research results it was indicated that “curve radius, super elevation and deflection angle have used in regression equations to predict operating speeds on horizontal curves. For tangents, tangent length is the primary alignment parameter that determines the speed” (Fitzpatrick et al., 2000).

According AASHTO (2011) the use of horizontal radius of curvature as a variable to predict 85th percentile speeds on curves have been used for many years. During this period, it becomes customary to predict the 85th percentile speed using geometric factors.

$$R = \frac{V_D^2}{127(e+f)} \quad \text{(Equation, 2.1)}$$

Where: R = radius of Curvature (m)

e = super elevation rate (m/m)

f = side-friction factor

V_D= vehicle speed (Km/h)

The objective in providing desirable horizontal alignment is to provide elements that are consistent with what drivers expect based on their experience on similar roadway and on previous sections of a particular roadway. Large difference and abrupt change in horizontal alignment should be avoided so that driver workload is not excessive.

2.2 Previous Studies on Design Consistency

2.2.1 Design Speed Approach to Roadway Design

Since the 1930s, the design-speed concept has been the principal quantitative mechanism for ensuring consistency of safe operating speeds along rural highway alignments. The concept arose from safety concerns about differentials between the speeds at which drivers could safely operating their vehicles on tangents and the lower speeds at which they could safely operate on horizontal curves .the solution implemented by the design speed concept was that all alignment features should be designed to accommodate the desired speed of most drivers using roadway or, other words that an appropriate design speed should be uniformly applied to all alignment elements of the roadway (Fitzpatrick et al.,2000).

One of the unifying elements of roadway design is the concept of "design speed. "The design speed concept assumes that curves meet or exceed the criteria for the selected design speed. Originally, the design speed concept had two fundamental principles:

- All curves along an alignment should be designed for the same speed.
- Design speed should reflect the uniform speed at which a high percentage of drivers desire to operate.

However, the design speed approach has two drawbacks. First, the design speed concept presumes that a design will be consistent if the individual alignment features share similar design speeds. Second, the design speed applies only to horizontal and vertical curves, not to the tangents that connect those curves. Consistency concerns developed when long tangents allow drivers to achieve their desired speeds but the resulting speed is in excess of the design speed of the following curve. A road can be designed to a constant speed but because it's constrained to minimum values at only certain location the road can appear to the driver to have a wide variation in design in design standard. On design section of in an area with generally uniform topography, a driver tends to have speed expectancy. This expectancy should be reinforced by designing to approximately uniform standard. It is important that driver are not presented with something unexpected; it is often more important that alignment standard are consistent than the exist. Research result show that 'inconsistency of the horizontal alignment of a road significantly increased accident rate, which were affected not only by individual curve radius and average horizontal curvature, but also by the combination of the two, A sharp curve on an otherwise straight alignment would cause a higher accident rate than that on an alignment with a high degree of bendiness' (Zegeer et al., 1992).

The design speed consistency measure is based on deviation design speed from operating speed. The greater the difference between the operating speed and design speed, the worse the consistency evaluation. This measure is used to check if actual driver speed meets design speed or not. Different researcher modeling the operating speed on horizontal curves as the function of geometric variables (table 2.1)

Table 2. 1 Regression equations of operating speeds on horizontal curves as a function of geometric variables

Authors	Equation	R^2	Sample size	Location
Taragin(1953)	V90 = 88.87*2554.76/R	0.86	35 curves	, Maryland, New York and South Carolina
Glennon et al (1985)	V85 = 103.96*4524.94/R	0.84	56 curves	Florida, Illinois, Ohio and Texas
Lamm and Choveini(1986)	V85 = 94.39*3189/R	0.79	261 curves	New York
Islam and Senevirctry(1994)	V85= 103.03*2408.76/R	0.79	8 curves	Utah
Ottesen(1993)	V85 = 103.64*3400.73/R	0.8	138 curves	New York, Washington .D.C
Voigt(1996)	V85 = 99.61*2951.37/R*0.014L*0.13 I*71.82	0.84	41 curves	Texas
Gonet(1999)	V85 = 147.88-7.162G-2.99e	0.84	43 curves	Ethiopia
Mefedden and Elefteriadou(1997)	V85 = 41.62-1.29D+0.0049Lc-12I	0.9	78 curves	United State
Where:V90 = 90^{th} percentile speed on a curve(km/h Lc = length of curve(m) V85 = 85th percentile speed on a curve(km/h)		I=deflection angle(deg) R= radius of curvature(m) e= Super elevation (m/m)		

Source: *(*Wooldridge, 20003)

2.3. Potential Measures of Geometric Design Consistency

Researches in design consistency focused on quantifying measures of design consistency and evaluation criteria to identifying them. The measures can be classified into four main classes: operating speed, vehicle stability, alignment indices, and driver workload. Following are brief summary of these different types of design consistency approaches.

2.3.1. Operating Speed Consistency Measure

The 85th percentile of free-flow speed distribution is commonly used to represent "operating speed for design consistency evaluations. Operating speed is defined as the speed selected by highway users when not restricted by other users, and is normally represented by 85th percentile speed. In terms of geometric design consistency, operating speed (V_{85}) is widely considered to be the most notable and straightforward geometric design consistency (Ghassan, 2014). The difference between operating speed and design speed (V_{85}- V_D) is a good indicator for any inconsistency at the simple horizontal curve and tangent whiles the speed reduction between two successive elements (change in V_{85}) can identifying any inconsistency experienced by drivers when travelling from one elements to the next. Speed profile equations predict operating speed along a roadway and determine sped differences between successive features. These equations can be used to visually check operating speeds between tangent segments and horizontal curves along the roadway. Horizontal curves may restrict the desired speed of drivers. Thus, to safely and comfortably traverse sharper curves, drivers must decelerate on entering the horizontal curve. The speed profile model then assumes that operating speed remain constant throughout the curve. Several studies have investigated the relationship to operating speed of design speed and various roadway characteristics on rural two-lane highways. Horizontal curvature is the most researched design elements related to operating speed. As evidenced by the vast number of studies available on the topic, a definite relationship exists between operating speed and horizontal curvature. In general, as the radius of the curve decrease or the degree of the curve increase, the operating speed decrease. Several models have to predict the operating speed on a rural two lane horizontal curve. Table 2.2 a sample of the models that predict speed at the midpoint of a horizontal curve. Table 2.3 the finding from the research on operating speed relationships on tangent section of rural two-lane highways.

Table 2. 2 Variables influencing midpoint horizontal curves operating speed for two rural-lane highway.

Author(year)	influencing Roadway or Roadside Variable						R^2
	Degree of curve	Radius	length of curve	deflection angle	Inferred speed	Grade	
Tarigan (1954)	X						0.74
Dept of Main Roads, New south Wales 91996)		X					0.83
Emerson (1969)		X					Na
McLean (1979)		X			X		0.92
Glennon (1983)	X						0.84
Lamm (1988)	X						0.79
Krammes et al. (1993)	X		X	X			0.82
Islam et al. (1994)	X						0.98
Fitzpatrick et al. (1999)		X				X	0.76
Schurr et al. (2000)			X	X		X	0.46

Source: (Hailu, 2007)

Table 2. 3 Variables influencing midpoint of operating speed on tangent for rural two – lane highways

Author(year)	Influencing roadway or roadside variable				
	Preceding and Succeeding curve	Access Density	Tangent Length	Grade	R
Parma(1999)		NF		X	NP
Polus et al.(2000)	X	NF	X		23-55
NP= not provide NF= study design limited range for this vary NF= study design limited range for this vary					

Source:(Wooldridge,20003)

In determining the design consistency of their roads, German designers use a parameter for the horizontal alignment called the curvature change rate (CCR). The CCR is the sum of angular changes in the horizontal alignment divided by the length of the highway section. This parameter is used in an attempt to prevent unsafe changes in operating speeds and to describe the overall operating characteristics of a road (Fitzpatrick et al., 2000).

The design speed consistency can be evaluated using three different categories and they are summarized as follows:

I) Good Designs: The change in the degree of curve is ≤5 deg and the change in operating speed V85 is less than or equal to 10 km/h between successive design elements. Design speed criterion: The difference between the operating speed and the design speed is less than or equal to 10km/h for the investigated curve or tangent. For these road sections, in consistency horizontal alignment exists and no improvements in geometric design would be necessary. No adaptations or corrections between design speed and operating speed have to be conducted.

II) Fair Designs: The change in the degree of curve is 5 <DC ≤ 10 deg and the change in operating speed 10 km/h < V85 ≤ 20 km/h between successive design elements. Design Speed Criterion: The difference between the operating speed and the design speed is 10 km/h < V85 - V_D ≤ 20 km/h for the investigated curve or tangent. These road sections exhibit minor in consistencies in geometric design. Normally, correcting the existing alignment may be avoided by using low-cost warning devices. Super elevation rates in curves should be related to the expected 85^{th} percentile operating speeds with respect to the degree of curve and not to the design speed.

III) Poor Design: The change in the degree of curve is >10 deg and the change in operating sped V_{85} >20km/h between successive design elements. Design speed criterion: The difference between the operating speed and design speed is >20km/h for the investigated curve or tangent. These road sections represent strong inconsistency in horizontal geometric design that may results in critical driving maneuvers. Accident rates will be higher for these road sections. The 85^{th} percentile operating speed should not be allowed to exceed the design speed by more the 20km/h. If such a difference occurs, an increase in the design speed is recommended.

The estimation of speed on curves is easier than the prediction of speed on tangent section because of strong correlation of speed on a few defined and limited variables, such as curvature, super elevation, and the side friction coefficients between road surfaces and tires. On tangent section, however, the speed of vehicles depends on a wide array of roadway characteristics (e.g. the length of tangent section, the radius of curve prior to and after the section, cross-section elements, vertical alignment, general terrain, and available sight distance).

2.3.1.1 Geometric Design Consistency Evaluation Criteria Based on Design Speed and Operating Speed

Leisch and Leisch (1977) concluded that design speed reduction should be avoided, but if they are necessary, they should not exceed 15 km/hr. Lamm et al. (2007) considered individual design elements (curve or tangents) along the observed roadway section, the absolute difference between the $V85^{th}$ percentile speed and the selected design speed should correspond to certain ranges.

The most commonly used method to evaluate road consistency was developed based on mean accident rates. They presented two design consistency criteria related to operating speed, which include the difference between design and operating speed and the difference between operating speeds on successive elements.

Table 2.4: Design evaluation criteria based on safety criteria I & II show the most common set of criteria used to determine the level of consistency of curve and tangent section in relation to operating speed.

Table 2.4 Design evaluation criteria based on safety criteria I and II

consistency rate	Criteria I(km/hr)	Criteria II(Km/h)	Evaluation
Good Design	$\|V_{85i}-V_D\|<10$	$\|V_{85i}+1 - V_D\|<10$	consistency exists
Fair Design	$10<\|V_{85}-V_D\|<20$	$10<\|V_{85}i+1- V_D\|<20$	Minor inconsistency exists
Poor Design	$\|V_{85}-V_D\|>20$	$\|V_{85i}+1 - V_D\|>20$	Strong inconsistency

Source: (Lamm et al., 1988)

Note: V_{85i} and $V_{85i}+1$ are operating speed on element I and i+1 respectively.V_{85} = V_{85}^{th} percentile operating speed (km/hr.); V_D = design speed of the roadway.

The table 2.4 classifies highway section into three categories. Where, Good = no highway alignment correction are required; Fair = no alignment correction is required, but correction may be desirable to signs, camber etc.; and Poor = alignment redesign is recommended.

2.3.1.2 Geometric Design Consistency Evaluation Criteria Based on Operating Speed

Lamm et al. (1988) quantified design consistency based on operating speed depending on the absolute difference of the 85th percentile speeds between successive designs elements (tangent to curve or curve to tangent) should fall into certain ranges:

Table 2.5: Design evaluation criteria based on safety criteria III show the most common set of criteria used to determine the level of consistency of curve and tangent section in relation to operating speed.

Table 2.5 Design evaluation criteria based on safety criteria III

consistency rate	Criteria III (km/hr)	Evaluation
Good Design	$\lvert \Delta V_{85} \rvert$ <10km/hr	consistency exists
Fair Design	10km/hr.< $\lvert \Delta V_{85} \rvert$ <20km/hr	Minor inconsistency exists
Poor Design	$\lvert \Delta V_{85} \rvert$ >20km/hr	Strong inconsistency

Source: (Lamm et a.l., 1988)

Note = ΔV_{85} = absolute difference of the 85th percentile speed between successive elements (km/hr). (i.e., from tangent to curve section or tangent to curve section).

In Table 2.5 classifies highway section into three categories. Where, Good = no highway alignment correction are required; Fair = no alignment correction is required, but correction may be desirable to signs, camber etc.; and Poor = alignment redesign is recommended.

A consistency and safe design when the difference between the operating speeds as on two successive elements must be less than 15% of the speed on the preceding quoted element (Cafiso and Cava, 2009). Speed reduction from tangent to the following curve design consistency evaluation criteria also concluded by (Abbas et al., 2011) and Lamm & Choueiri (1987) that speed reduction from tangent to the following curve does not exceed 10km/hr (Good design).

2.3.2. Vehicles Stability Consistency Measurement

Another method to evaluate design consistency is the study of vehicle stability. In field of geometric design, the most important characteristics of the road surface are its skid resistance. When insufficient side friction is provided at a horizontal curve, vehicles may skid out, rollover or be involved in head on crashes. According this statement, locations that do not guaranty enough vehicle stability can be considered as geometric design inconsistencies. In this sense, a design consistency criterion which includes the difference between the side frictions assumed of the road and the side friction demanded by the driver.

The design consistency evaluation can be done based on margin of safety of the difference between side friction assumed and side friction demand on a curve (Δf_R). If friction demand exceeds supply, this may prohibit safe vehicle operation and would imply inconsistency and vehicle instability. Location that do not provide vehicle stability can be considered geometric design inconsistency (Krammes et al., 1995b).

2.3.2.1 Geometric Design Consistency Evaluation Criteria Based on Vehicle Stability

Lamm et al. (1991) presented a design consistency criteria, which includes the difference between side friction assumed or supplied (f_{RA}, that depends on design speed and demanded (f_{RD}, that depends on the operating speed), denoted as Δf_{RD}, was used to represent vehicle stability. According to this criterion, consistency is considered good when Δf_R is higher than or equal to 0.01, fair when its value is between 0.01 and -0.04, and poor when Δf_R is lower than -0.04.The consistency evaluation criterion for Δf_R, to predict the side friction assumed are dependent on either the operating speed or design speed of an element and table 2.6 design evaluation based on safety criteria IV shows the most common set of criterion used to determine the level of consistency of a highway section.

Table 2.6 Design evaluation on safety Criteria IV

Consistency rate	**Criteria** IV	**Evaluation**
Good Design	$\Delta f_R > 0.01$	Consistency exists
Fair Design	$0.01 > \Delta f_R \geq -0.04$	Minor inconsistency exist
Poor Design	$\Delta f_R < -0.04$	Strong inconsistency exist

Source: (Mulugeta, 2015)

Note: $\Delta f_R = f_{RA} - f_{RD}$ (difference between side friction supplied and side friction demand), where f_{RA} and f_{RD} are side friction assumed and demanded on element *i*, respectively.

In table 2.6 classifies highway section into three categories. Where, Good = No highway alignment correction are required; Fair = no alignment correction is required, but correction may be desirable to signs, camber etc., and Poor = alignment redesign is recommended.

Vehicle stability is an important measure of Design consistency. When the horizontal curve lacks vehicle stability, meaning its friction assumed is insufficient, vehicle may slide out or be involved in head on collisions. When a roadway lacks vehicle stability, it violates drivers' expectation and their ability to guide and control the vehicle in the safe manner, thus can be considered as a geometric design inconsistency. As such, assessing vehicle stability can help identify inconsistent location. The different between side friction assumed and side friction demand, which is denoted as change Δf_R is used to represent.

Accounting for vehicle stability in highway design is an important issue to ensure safe traffic operation. Excessive centrifugal forces experienced on a vehicle moving on a horizontal curve may lead to vehicle roll-over.

In current design practice, the centrifugal force is balanced by the side friction between the vehicle's tires and the pavement and the weight component resulting from the super elevation according to the following model (AASHTO, 2011).

$$R = \frac{V_D^2}{127(e+f)} \qquad \text{(Equation, 2.2)}$$

Where

R = radius of curve (m); V_D = design speed (km/hr); f = side friction factor; and e = super elevation rate.

Several safety problems can be found in this practice regarding vehicle stability. For example, the effect of a vertical curve or grade combined with a horizontal curve has not been considered. First the vehicle is represented by a point mass rather than a body, thus the variation in the distribution of friction force between different tires is not considered. Second, the formula assumes that the vehicle moves with the constant speed and that the drivers follow a path with a certain radius equal to the curve radius that may not be true (Gennon and Weaver, 1972).

Alignment indices are a quantitative approach to evaluate design consistency based on vehicle stability that was represented by the difference between side frictions assumed and side friction demanded. To values of side friction assumed were determined for each curve using the (AASHTO, 2011)guide formula as follows.

$f_{RA} = \frac{V_D^2}{127R} - e$……………………………………………………………….(equation, 2.3)

Where:

f_{RA} = Side friction assumed ,V_D = Design Speed (km/h, and

e = super elevation rate (m/m); and R = radius of horizontal curve (m) and

The value of side friction demanded f_{RD} were calculated for each curve using the (AASHTO, 2011) guide as follows.

$f_{RD} = \frac{V85^2}{127R} - e$……………………………………………………..…………(Equation,2.4)

Where

f_{RD} = Side friction demand; and V_{85} = V_{85}th percentile Observed operating speed(km/hr),

e = super elevation rate (m/m); and R = radius of horizontal curve (m).

2.3.3 Alignment Indices

Alignment indices are quantitative measures of the general character of a roadway segment's alignment that that appear to have several conceptual advantages for use in design consistency evaluation. They would be a function of the dimensions of horizontal and /or vertical alignment elements. "Alignment indices did not explain the variation in measured speeds on long tangents'' (Wooldridge, 2000).If logically formulated, they should be easy for designers to use, understand, and explain. They would be a function of the dimension of horizontal and/or vertical alignment elements. Therefore, they would provide a mechanism for quantitative assessments evaluation of successive elements from a system wide perspective, which is a fundamental motivation of design consistency of this research. It is a poor predictor of speed on long tangents; alignment indices may be able to provide an indication of the consistency of two-lane rural highway.

The proposed indicators of geometric inconsistency include:-

- A large increase/decrease in the value of alignment indices for successive roadway segments.

- A high rate of change in alignments indices over some length of roadway.
- A large difference between the individual feature and the average value of the alignment geometric elements.

For each of these, a determination must be made of the amount of change in the alignment geometric elements value that would indicate a significant change in alignment consistency.

3.3.3.1 Geometric Design Consistency Evaluation Criteria Based on Alignment Indices

Design consistency evaluation criteria based on alignment an index is not as well established as those based on operating speed vehicle stability. Nonetheless, there are rules pertaining to geometric design features which are included in some European design standard and are in (table 2.7).

Table 2.7 Design Consistency Evaluation Criteria Based on Alignment Indices

consistency rate	Criteria	Evaluation	Source
Good design	$\Delta DC \leq 5°$	consistency exists	(R. Lamm and E. M. Choueiri, 1987)
Fair design	$5° < \Delta DC \leq 10°$	Minor inconsistency exists, traffic warning devices warranted	
Poor design	$\Delta DC > °10$	Strong inconsistency, redesign consistency recommended	
Good design	$\lvert CCR_i - CCR_{avg} \rvert \leq$ 180gon/km	consistency exists	(Lamm et al., 1999)
Fair design	$180 < \lvert CCR_i - CCR_{avg} \rvert \leq$ 360gon/km	Minor inconsistency exists, traffic warning devices warranted	
Poor design	$\lvert CCR_i - CCR_{avg} \rvert >$ 360gon/km	Strong inconsistency, redesign consistency recommended	
Good design	if DC < 4.24° and if radius of successive curves(separated by a short tangent) are equal	consistency exists	(Al-Masaied et al, 1995)
ΔDC = change in degree of curve between successive design elements; CCR_i, CCR_{avg} = value of design element I and the average value, respectively.			

Source :(Joane, 2002)

2.3.3.2. Identification of Alignment Indices

The initial step in determining the alignment indices consisted of identifying all possible indices that may be useful for this study. Therefore, some of the alignment indices that had been used in other countries or proposed for use were included. All of these alignment indices could possibly provide an indication of the geometry motorists experience on the roadway.

2.3.3.3 Proposed Alignment Indices

A number of potential alignment indices have been studies, some of which are not recommend er by researchers. The alignment indices recommended as potential measures of design consist ency on a road section were:

1. Average radius of curvature (AVGR);
2. Maximum radius of curvature to minimum radius of curvature (MR/MR);
3. Average tangent length (AVGT);
4. Curvature change rate (CCR); and
5. Ratio of individual curve radius to average radius (CRR).
6. The ratio of curve length to roadway length

Based on Fitzpatrick et al. (2000) recommended that the first four alignment indices are to be investigated as possible measures of rating the design consistency of rural two - lane highways. Based on crash analysis, Anderson et al. (1999) suggested that the ratio of the curve radius to average radius has a significant relationship to safety.

Average Radius of Curvature

The average radius (AVGR) expresses the sharpness of the curve representative of a given section of the roadway and what motorists typically encounter on curve section of the road. Sharper curves are associated with higher accident rates than milder curves (Wooldridge et al., 2000). AVGR determined by dividing the sum of curve radius on a highway section by the number of curves on that section as show in equation (2.5).

AVGR (M) $= (\sum_{i=1}^{n} Ri)/n$.. (Equation, 2.5)

Where

Ri = radius of curve (m), and

n = number of curves within section.

Ratio of Maximum Radius to Minimum Radius

The range of the radii along a roadway can be determined by computing the ratio of the maximum radius to minimum radius($\frac{MR}{mR}$). This ratio can be representing "the consistency of design in terms of the use of similar horizontal radii along the road. As the ratio value approaches one, a reduced accident rate may be expected or as the ratio value less than one the accident rate may be high"(Anderson et al., 1999a). The ratio of the maximum radius to the minimum radius is not recommended as a design consistency measure due to its relatively low sensitivity to crash frequency compared to other alignment indices studied (Anderson et al., 1999). Fitzpatrick et al. (2003) recommended that a better using the average radius as an alignment indices rather than the maximum radius to the minimum radius. To calculate the maximum radius to the minimum radius ratio is as follow in equation (2.6).

$$\frac{MR}{mR} = \frac{R_{max}}{R_{min}} \quad \text{(Equation, 2.6)}$$

Where

R_{max} = the maximum radius of the highway section, and

R_{min} = the minimum radius of a highway section.

Average tangent length (AVGT)

The tangent length plays an important role in determining the necessary speed reduction of motorist as they enter a horizontal curve. The length of tangent determines the speed motorist will reach on that tangent. If tangent is long enough, the motorists will drive at desired speed, which defined as "the speed at which drives choose to travel under free-flow condition when they are not constrained by alignment features (Mclean, 1981). Therefore, if motorists are driving at high speed on the tangent and a large reduction in speed is required at the following curve, they may not be able to decrease their speed as needed (Fitzpatrick et al., 2000a). A comparison of individual tangent length to the average tangent length appears to be very valuable in rating design consistency of the roadway. It shows the amount of variation for each individual tangent and can possibly be used in determining location where motorists may be expecting the tangent to be longer than they are. The average tangent length (AVGT) indicates the length of tangent that is typically available to motorist between curve sections of the roadway. Average tangent is calculated in equation (2.7).

AVGT (m) = $\frac{\sum_{i=1}^{n} Ti}{n}$.. (Equation, 2.7)

Where:

Ti = tangent length of each section (m), and

n = number of tangents within section.

Curvature change rate (CCR)

Fitzpatrick et al. (2000a) stated that Curvature change rate (CCR) expresses the absolute sum of the angular changes in the horizontal alignment divided by the length of the highway section. This parameter assumed to be more representative of the general character of the alignment of the roadway, a large value for these indices indicates that the road either contains a large number of curves or there are long or Sharp curves in that section. It was expected that an increase in the value of these indices would decrease the desired speed of motorists(Fitzpatrick et al., 2000a). Curvature change rate is calculated in equation (2.8).

CCR (deg/km) =$\frac{\sum_{i=1}^{n} \Delta i}{Li}$.. (Equation, 2.8)

Where: $\Delta i =$ defelection angle (deg), and

Li = length of each section (m).

Chen et al. (2011) found that the CRR is a more appropriate to describe the geometric properties of several elements. In general, a higher CRR is associated with higher accident rate.

Curve Radius to Average Radius (CRR)

The individual curve radius to average radius characterizes the relationship between each individual horizontal curve radius to the average radius of the roadway section as a whole; Anderson et al. (1999a) found that highway safety is sensitive to CRR and suggested using this ratio as a consistency measure. When the radius of a horizontal curve deviates greatly from the average radius along the roadway section, that curve may violate driver expectancy, creating inconsistency.

The ratio CRR for specific curve section can be calculated in equation (2.9).

$$CRRi = \frac{Ri}{AVGR} \qquad \text{(Equation, 2.9)}$$

Where:

Ri = radius of the i^{th} curve on the roadway section (m), and

AVGR = Average radius of curvature (m).

The ratio CRR as the value approaches 1.0, a reduced crash frequency is expected. A curve with a CRR ratio value of 0.5 will be considered by many to have a relatively higher potential for crashes.

2.3.4. Driver Workload

As explained previously, the roadway, the vehicle, and the driver interact in an interrelated manner. Therefore, it is logical to include driver workload as a measure of design consistency. Driver workload can be defined as “the rate at which drovers must perform the driving task that changes continuously until it is completed” (Anderson et al., 1999a). Both the time available to perform the task and the complexity of the driving environment considerably affect the mental effort required. Conceptually, driver workload can be more appealing for identifying inconsistency than operating speed because it represents the demanded placed on the driver by the roadway, while operating speed is only one of the observable outputs of the driving task. However, the However, the use of driver workload is much more limited than operating speed because of its subjective nature (Krammes and Glascock, 1992).

Driver’s expectancy is an important component of driver workload. It is defined as the driver’s readiness to respond to the driving situation predictably and perform the driving task successfully (Lunenfeld and Alexander, 1984). There are two types of expectancy: a priori expectancy and ad hoc expectancy. The a priori expectancy is the long- term expectancy developed cumulatively from previous experience, while the ad hoc expectancy is the short-term expectancy which is acquired during the present task. If either type of expectancy is not met, collision may result (Fitzpatrick et al., 2000).

A consistency roadway geometry allows a driver to accurately predict the correct path while devoting little visual information processing capacity, thus allowing attention or capacity to be dedicated to obstacle avoidance and navigation.

2.3.4.1 Proposed Evaluation Methods of Driver Workload

Driver workload is not easily measurable by analytical model; however, several methods have been developed to quantify the effects of design consistency on driver workload. In general, workload measurement techniques fit into four different methods to objectively measure driver workload: the primary task method, the secondary task method, the direct measurement of psycho-physiologic variables, and the information storage method. Most recent studies have been conducted using the information storage method. This method assumes that the intensity of the driver’s attention varies depending on the driving environment and the perceived risks (Krammes et al., 1995).The amount of time the driver needs to view the roadway is measured to calculate the visual demand, which is the proposed measure of driver workload. Visual demand is defined as the amount of visual information needed by the driver to maintain an acceptable path on the roadway (Wooldridge et al., 2000).

2.3.4.2 Proposed Measures of Driver Workload

Subjective rating scale has been developed by (Messer, 1980). To estimate the average workload and the level of consistency of nine basic geometric features with a scale from 0 (no problem) to 6 (critical problem), 21 highway design engineers and researchers rated the features according to the feature type, design attributes, sight distance, separation distance, operating speed, and driver familiarity. The ratings are summarized in table 2.8. An expression to estimate the driver workload of a geometric feature is developed based on these rating and is included in Table 2.9. The rating provides a good basis for a priori expectancy evaluation.

Table 2.8 summary of geometric feature rating for average conditions on two - lane rural highway

Geometric Feature	Two – lane	
	High	Medium
Bridge		
Narrow Width, No Shoulder	5.4	5.4
Full Width, No Shoulder	2.5	2.5
Full Width, With Shoulder	1	1
Intersection		
Unchannelized	3.7	2.8
Channelized	3.3	2.5
Railway Grade Crossing	3.7	3.7
Shoulder With Change		
Full Drop	3.2	2.4
Reduction	1.6	1.2
Alignment		
Reverse Horizontal Curve	3.1	2.3
Horizontal Curve	2.3	1.7
Crest Vertical Curve	1.9	1.4
Lane - Width Reduction	3.1	2.3
Crossroad Overpass	1.3	1
Level Tangent section	0	0

Source: (Messer, 1980)

The equation 2.10 to calculate the workload on two – lane rural highways at the feature (Messer, 1980).

$W_{Ln} = U.S.E.R_f + C.W_{Ln-l}$………………………………………………… (Equation, 2.10)

Where:W_{Ln}=workload at feature = driver unfamiliarity factor ($0.4 < U < 1$),

S = sight distance factor ($0.6 < S < 1.8$), E = feature expectation factor (E = 1 if feature is not similar to n-1 feature, otherwise E = 1 – C), R_f = workload rating (from table 2.9),

C = feature carryover factor ($0 < C < 1$, depending on the distance between features) and

W_{Ln-1} = workload value for the preceding feature n-1.

2.3.4.3 Geometric Design Consistency Evaluation Criteria Based on Driver Workload

Some of the proposed indicators of design inconsistency based on driver workload include a high workload and a large positive change in workload. Subjective level of consistency criteria as found in Table 2.9, which is based on the workload evaluation developed by (Messer et al., 1981) Can also be used to identify inconsistency geometric features. Still, an acceptance limits to change in visual demand should be developed to help facilitate evaluation (rammes et al., 1995a).

Table 2.9 Driver Workload – based Level of Consistency Criteria

Level of Consistency	Workload Value(W_{Ln})	Driver Expectation
A	≤ 1	No problem expected
B	≤ 2	
C	≤ 3	Small surprises possible
D	≤ 4	
E	≤ 5	
F	≤ 6	Big problem possible

Source: (Messer, 1980)

2.4 Posted Speed

Posted speed refers to the maximum speed limit posted on a section of highway using the regulatory sign. The Texas Department of Transportation's Procedure for Establishing Speed Zones States that the posted speed "Should be based primarily upon the 85th percentile speed when adequate speed samples can be secured".

2.5 Terminology Speed Used for This Study

2.5.1 Speed

The definition of speed can take many forms and is one of the most important parameters in the geometric design of highway. The term 'speed' is general term typically used to describe the actual speed of a group of vehicles over a certain section of roadway (Fitzpatrick et al., 2000a).

Speed is a fundamental factor in transportation engineering; it is often denoted by different terms while applied in different situation such as design criteria, a measure of the level of service and an operation control parameter (Hassan et al., 2007). The types of speed terminologies are listed in table 2.7.

Table 2.10 speed terminology

type of speed	Description	Source
Design speed	As a speed selected to established specific minimum geometric design element or a particular section of highway. Other features such as width of pavement and shoulder, horizontal and vertical alignment and etc. Are generally related to design speed.	(Anderson et al., 1996)
	As speed selected as a basis to established appropriate geometric design for a particular section of road including horizontal and vertical alignment, super elevation, sight distance, etc	(Lamm et al., 1991)
	A design speed should be a logical one which respect to the topography, anticipated operating speed, the adjacent land use, and functional classification of the highway; and once selected, all the pertinent features of the highway should be related to the design speed.	(AASHTO, 2011)
Operating speed	The highest overall speed at which a driver can travel on a given road under favorable weather condition and prevailing traffic condition without at any time exceeding the design speed on a section by section basis.	(Anderson et al., 1996)
	The speed selected by the highway users when not restricted by the other users (i.e. under free flow condition).	(Pot et al., 1996)
	The speed at or below in which 85th percentile of drivers are operating their vehicles.	(Fitxpatrick et al., 2003)
	The speed at which a driver is observed operating a vehicle (a spot speed at particular section). Reported as a mean or 85^{th} percentile operating speed.	(Lamm et al., 1991)
	The speed at which a driver is observed operating their vehicle during free-flow condition. The 85th percentile of the distribution of observed speed is the most frequency used measure of the operating speed associated with a particular location or geometric feature.	(AASHTO, 2011)

	The operating speed is the 85th percentile speed that drivers judge to be passible under prevailing traffic condition on the road in question, but in the absence of cross- traffic.	(Wooldridge et al., 2003)
The 85^{th} percentile speed	The 85^{th} percentile operating speed is accepted as safe speed in highway condition. Usually 15percent of the driver are considered as endangering and exceeding speed limit in the traffic flow, so these values become criteria to fix the maximum speed limit and as design value to carryout design works in highway geometric design.	(Lamm et al., 1995)
	The 85^{th} percentile is used in evaluating or recommending posted speed limits based on the assumption the 85 percent of the drivers are travelling at speed that are perceived to be safe. In others words, the 85th percentile operating speed is normally assumed to be the highest safe speed for the road section.	(Lamm eet al., 1995)
	The distribution of observed speed is the most frequency used descriptive statistics for the operating speed associated with a particular location or geometric feature.	(AASHTO, 2011)

2.6 Model Development

2.6.1 General Concept

The model will be useful for detecting design errors. They are helpful are for feasibility studies and for analysis of design alternatives. Can be used to analyze an existing road, detect failures, and study improvement alternatives. Speed adopted by drivers often responds not to engineer's design speed but to geometric characteristics of the road (Iyinam et al., 2000). On a road element, drivers consider two efficiency measures: speed and comfort. They frequently prefer to feel a certain degree of discomfort in exchange for obtain greater speed. For some geometric condition, drivers adopt a speed that sacrifices not only comfort but also safety. The highway engineer plays an important role in traffic safety. If the operating sped differs from that expected by the engineer, the following can happen: drivers do not travel safely and comfortably or not satisfied, and the operational cost and travel time are different from those estimated. The design speed concept, as used today, gives rise to geometric design at times unsafe for speed used by drivers. For this reason, the actual behavior of drivers on the road should be used to design geometric elements.

Operating speed was illustrated in many research works is the parameter most representative of real driving performance and it is defined as the speed at which drivers travel on a dry road in free flow condition during daylight hours and it is calculated using a specific percentile of speed distribution, typically the 85^{th} percentile. Many mathematical models were developed to estimate vehicular speed on curves and tangents as a function of some geometric road characteristics and no - geometric features, and several analyses of driver speed behavior when the driver is entering and departing circular elements have been conducted to measure deceleration and acceleration rates.

2.6.2 The concept of generalized linear models (GLMS)

The term general linear model (GLM) usually refers to conventional linear regression models for a continuous response variable given continuous and/ or categorical predictors and has been on describing interaction or association between two or more than two categorical variables mostly via single summary statistics and with significant testing. The model parameters provide measures of strength of association and Statistical Inference in GLM There are at least two parts (but sometimes other parts as well) behind the logic of statistically testing a GLM. The first of these deals with the overall model and effectively asks how well the model explains the data regardless of the individual independent variables in the model. The second part examines the effects of individual independent variables usually with an eye towards distinguishing those independent variables that contribute significantly to prediction from those that add little to the model. The general linear models (GLMs) are abroad class of model that includes linear regression, ANOVA, Poisson, Log-linear models etc. (table 2.11).

Table 2.11 Summary of General Linear Models

Model	**Random**	**Link**	**Systematic**
Linear Regression	Normal	Identity	Continuous
ANOVA	Normal	Identity	Categorical
ANCOVA	Normal	Identity	Mixed
Logistic Regression	Binomial	Logit	Mixed
Loglinear	Poisson	Log	Categorical
Poisson Regression	Poisson	Log	Mixed
Multinomial response	Multinomial	Generalized Logit	Mixed

The three components to any GLM:

- Random Component:- refers to the probability distribution of the response variable(Y), e.g. normal distribution for Y in the linear regression, or binomial distribution for Y in the binary logistic. Also called a noise model or error model. How is random error added to the prediction that comes out of the link function?
- Systematic Component: - Specifies the explanatory variables (X_1, $X_2 \ldots X_K$) in the model, more specifically their linear combination in creating the so called linear predictor, e.g., $\beta_0 + \beta_1 x_1 + \beta_2 x_2$ as well have seen in a linear regression.
- Link Function, η or g(μ):-Specifies the link between random and systematic components. It says how the expected value of the response relates to the linear predictor of explanatory variables; e.g., $\eta = logit(\pi)$ for logistic regression.

The mathematical form expresses the dependent variable for any given observation as the sum of three components: (1) the intercept; (2) the sum of the weighted independent variable; and (3) error. For k independent variable, the fundamental equation for the general linear model is

$\mathbf{Y = \beta + \beta_1 X + \beta_2 X + \ldots \beta_k X_k + \varepsilon}$………………………………………………… (Equation, 2.11)

Multiple Linear Regressions

The concept of multiple linear regression model where describe how a single response variable Y depends linearly on a number of predictor variables (X_1, $X_2, \ldots X_K$) and a multiple linear regression model with K predictor variables X_1, $X_2, \ldots X_K$ and a responses Y, can be written as.

$\mathbf{Y = \beta + \beta_1 X + \beta_2 X + \ldots \beta_k X_k + \varepsilon \ldots}$……………………………………………… (Equation.2.12)

Simple Linear Regression

The concept of simple linear regression model where describe how a single predictor variable X was used to model the response variable Y. depends linearly a predictor variables (X_1) and and a responses Y, can be written as

$\mathbf{Y = \beta + \beta_1 X + + \varepsilon}$……………………………………………………… (Equation, 2.13)

2.6.3 Models the 85th Operating Speed for Simple Curve

In simple horizontal curves, speed reduction is significantly affected by the degree of curves, gradient, and length of curves, defection angle, and radius of curves, super elevation, cross – section, within horizontal curve as well as pavement condition. "The degree of curves was found to be the most important variable. Gradient did not have significant influence on the speed of passenger cars. Super elevation rate, lane and shoulder widths, and grade up to 3 percent did not have a statistically significant effect on curve speed" (Wooldridge, 20003) and In addition the research results indicate that "lane and shoulder widths, super elevation rate, prevailing terrain, and posted speed for passenger cars and trucks had no effect on the speed reduction". Vogit and Bared (1996) found a relationship between the speed on horizontal curves and degree of curvature, as well as other variables. Polus et al. (2000) found a statistically significant multiple- linear regression equation using the independent variables degree of curvature, length of curve and deflection angle.

The linear regression model on the curve is

V85 = ß + ß1X1+ ß2X2……………………………………………………….. (Equation.2.14)

ß1, ß2… is the independent variable coefficient

X1, X2 …is the independent variables

V85=85th percentile operating speed on curve (km/h);

2.6.4. Models the 85th Operating Speed for Common Tangent

Estimation of the operating speed from the highway geometric is the first step in the consistency evaluation process and Models were developed by many researchers to quantify the relationship between the speed and geometry (Jacob et al., 2013). The length of the common tangent between successive curves is considered one of the important geometric design consistency variables. For each type of vehicle, the research results indicate that the dependent variable (speed) on the common tangent was found to be strongly correlated with the independent variable (the length of common tangent (LT), grade of tangent (%), degree of successive curves (Dc), and the deflection angles of successive curve (Da)). However, the degrees of curves were also found to be positively correlated with their deflection angles (Fitzpatrick et al., 2000).

The linear regression model on the tangent is

$\mathbf{V_{85} = ß + ß1X1 + ß2X2}$……………………………………………………..…(Equation, 2.15)

ß1, ß2… is the independent variable coefficient

X1, X2 …is the independent variables

V_{85} = V_{85} percentile operating speed on tangent

2.7 Review of Design Guides and Manuals.

The discussion contained in this sub section is not intended to be an exhaustive review of the geometric design manuals and guide worldwide, but to cite some important points relevant to the consistency considerations given in specific manuals which are commonly referred

2.7.1 AASHTO Geometric Design of Highways and Streets

This geometric design manual provides guidance on almost all aspects of road alignments. Design theories, concepts, policies and procedures are condensed and written for use by the designer. The manual has been developed to give the designer a basic working knowledge of geometric design of highways.

According AASHTO (2011), geometric design manual defines design speed as the maximum safe speed that can be maintained over a specified section of highway when conditions are so favorable that the design features of the highway govern. The adopted design speed should be the logical one with respect to the topography, the adjacent land use and the type of highway. When designing a substantial length of a highway, it is desirable to adopt a constant design speed.

According AASHTO (2011) states three kinds of speeds for design. These speeds are operating speed, running speed and design speed. The operating speed is the most frequently used speed associated with a particular location or geometric feature. The average running speed of all vehicles is used as a measure for evaluating level of service and road user costs. The design speed is selected in order to fit the travel desires and habit of all drivers expected to use particular facility.

In the manual, the selected design speed establishes the limiting value of curve radius and minimum sight distance that should be used in design; there is no restriction on the use of flatter horizontal curves or greater sight distances where there are no constraints as a part of an economical design. Higher speed selection is encouraged in tangents between sections of curved alignments. The selection of design speeds depend on the average trip length.

2.7.2 South Africa Geometric Design Manual

This design manual considers the significant of consistency related to physical elements of the road to the requirements of the driver, vehicles and the environmental situation are considered. With the major response to drivers' requirements being related to consistency of design, the manual considers three elements of consistency for the evaluation of a road design.

1). Design consistency:-This evaluation to relating the design speed to actual driving behavior which is expressed by the 85^{th} percentile speed of passenger cars under free-flow conditions. Accordingly, if the difference between design speed and 85^{th} percentile speed on an element such as a horizontal curve is less than 10km/h, the design is considered as good design. A difference of between 10km/h and 20km/h results in a tolerable design and difference greater than 20km/h poor design.

2). Operating speed consistency: - Seeks uniformity of percentile speeds through successive elements of the road; the point is that the difference in operating speed in moving from one element to other element, e.g. from a tangent to follow curve. A difference in operating speed between adjacent elements of less than 10km/h is considered to be good design, a difference of between 10 and 20 km/h is tolerable design, and a difference greater than 20km/h result is considered to be poor design.

3). Consistency in driving dynamics:-This is related side friction assumed with respect to the design speed to that demanded at the85th percentile speed. The side friction assumed for the design speed should exceed the side friction demanded by 0.01 or more. A difference between -0, 04 and 0, 01 result in a fair design, a value of less than-0, and 04 is not acceptable. A negative value for the difference between side friction assumed for design and the side friction demanded means that drivers are demanding more side friction than is assumed to be available ,that is potentially dangerous situation.

2.7.3 ERA Geometric Design Manual

According to the design manual, the design speed is used as an index which links the road function, traffic, the terrain to the design parameters of sight distance and curvature to ensure that a driver is presented with a reasonably consistent speed environment. In practice, most roads will only be constrained to minimum parameter value over short section or on specific geometric elements. Design elements such as lane and shoulder widths, horizontal radius super elevation, sight distance and gradient are directly related to, and vary with design speed.

The design manual does not consider the operating speed to fix design speeds. The safety problem due to inconsistency of geometric design is a vital but the manual lack appropriate consideration on design consistency. This makes the manual weak comparing with manual reviewed on this literature review.

2.7.4 AACRA Geometric Design Manual

In this manual has been developed to set the framework for the planning and design of new and upgraded roads in Addis Ababa.

The manual consistency states high geometric standard with design speed of 100 to110 km/hr. Operating speed on horizontal curves and straights are not significantly difference and typically do not exceed 110km/hr. However, on road where the geometric elements are designed for speed less than 100km/hr, operating speed will vary over the length of the road with greater speeds being used on straight and flatter radius of curvature.

The manual recommended that the design speed of successive horizontal curves should decrease by not more than 15km/hr. with a desirable change not exceeding 10km/hr.

2.7.5 AUST ROADS Rural Rod Design Manual

In this manual the selection of speeds for geometric design, the guide defines four speed parameters.

1). Desired speed: this is the operating speed that a driver will adopt on the less constrained elements, that is straight and large radius horizontal curves of a more or less uniform section of road when not constrained by other vehicles.

2). Speed environment: It is numerically equal to the desired speed of the 85^{th} percentile driver over that road section and thus by definition, is equal to the 85^{th} percentile of the observed free speed distribution on the longer straight or flat radius curves on the section, at lower traffic volumes. It can be measured on existing road, but must be estimated for design of a new road and is a basic parameter to be used in road design. It is important to note that it applies to a section of road rather than to an individual element.

3). Design speed: It applies to individual geometric elements and is the speed that is used to co-ordinate sight distance, radius, super elevation and friction demand for the elements of road so that a driver negotiating each elements as its design speed will not be exposed to be exceeded by most drivers.

4). Limiting curve speed standard: This is the speed at which a vehicle is traveling on a curve of given radius and super elevation. It must be at least equal to the design speed, but due to the actual combination of radius and super elevation selected, it may be higher than the design speed, in which case a vehicle traveling at the design speed will not utilize the full design friction supply of the road surface. The limiting curve speed must never be below the design speed.

In the literature review the general whole concepts are: - The geometric design element that influence driver behavior and possess the most potential for accident and /or safety is the horizontal curve and tangent section inconsistency. The horizontal curves whose design speed is less than drivers' desired speed show operating speed inconsistency that increase accident potential. The design speed concept assumes that curves meet or exceed the criteria for the selected design speed. Originally, the design speed concept had two fundamental principles:

i. All curves along an alignment should be designed for the same speed
ii. Design speed should reflect the uniform speed at which a high percentage of drivers desire to operate.

Four types of design consistency methodology: based on speed prediction model, alignment indices, and vehicle stability and driver workload. From these four methods speed prediction model and vehicle stability are the most commonly used model. The design speed consistency can be evaluated three different categories: Good Design, Fair Design and Poor Design.

AASHTO states three types of speeds for design. These speeds are operating speed, running speed and design speed. The operating speed is the most frequently used measure of the design associated with a particular location or geometric feature. The average running speed of all vehicles is uses as a measure for evaluating level of service and road user costs. The design speed is selected in order to fit the travel desires and habit of all driver expected to use particular facility. With the major response to drivers' requirements being related to consistency of design, the South Africa manual considers three elements of consistency for the evaluation of a road design: design consistency, operating speed consistency and consistency in driving dynamics.

The design speed is used in ERA geometric design manual as an index which links road function, traffic flow and terrain to the design parameters of sight distance and curvature to ensure that a driver is presented with a reasonably consistent speed in environment. AACRA manual recommends the design speed of successive horizontal curves should decrease by not more than 15km/h, with a desirable change not exceeding 10km/h.

AUSTROADS Rural Road Design guide states, on road of consistently high geometric standards, speed on curves and straight not significantly different. The speed selected by driver on road with speed environments below 100km/h is influenced by characteristics of the road and its surroundings. The 85^{th} percentile speed on an individual road element, which is to be used as the design speed to co-ordinate the geometric features, is principally a function of two parameters: speed environment and horizontal curve radius. Sight distance appears to have only a limited effect on observed 85^{th} percentile speeds.

3. MATERIALS AND METHODS

3.1 Introduction

This chapter presents and describes the approaches and techniques the researcher will use to collect data and investigate the research problem. They include the research design, sample size and selection, sampling techniques and procedure, data collection and procedure of data collection,

3.2 Description of Study Area

In order to achieve the objective, one-way, two-lane rural highway road located in the South Ethiopia were selected because in the rural road applied high operating traffic speed. These roads included Shashemene to Wolyta Sodo and Shshemene to Asela and would be conducted on two-lane rural highway. The of Shashemene Zone at the distance of 240km from the capital of Addis Ababa, the capital of Wolayta Sodo Zone at the distance of 317km from Addis Ababa and the capital Asela Zone at the distance 175km from Addis Ababa. The distance from Shashemene to Asela is 198km and the distance from Shashemene to Wolayta Sodo is 130km. On these two rural two-lane highways roads,fourty five simple horizontal curves section and Fourtiy Five tangent section were seleced whose Operatingd speed data will be collect on simple horizontal curves and tangent section. For this study the section sites are define as simple horizonta curve is proceed by straight tangent section with length of at least 180m and selected sites considering the following criteria.

Based on reviewing the data for each route and eliminating portions of the roadway with features that might interfere and affect the accuracy of the analysis, the following constraints (limitation) were imposed for the selection of highway segments:

- The selected section should be far from 50 meters from the intersections and 100 meters from the military checkpoints or any physical features that may create abnormal Conditions that influence operating speeds, such as narrow bridge, speed reducer.
- The pavement and shoulder width be constant for both tangent and curve sections.
- The tangent and subsequent curves should have the same pavement conditions.
- No stop-controlled or the signalized intersections nearby.

- ❖ Not located close to towns or built up areas that may significantly affect the speed patterns on the curves.
- ❖ Horizontal curves with radius < 100m were eliminated and those with radius >2000m were treated as tangent (based on recommendation of previous research; (Awatta, 2003).
- ❖ The road must good dry condition because in wet or rainy condition that makes the operating speed become slowly. These criteria are recommended in several studies (Awatta, 2003).

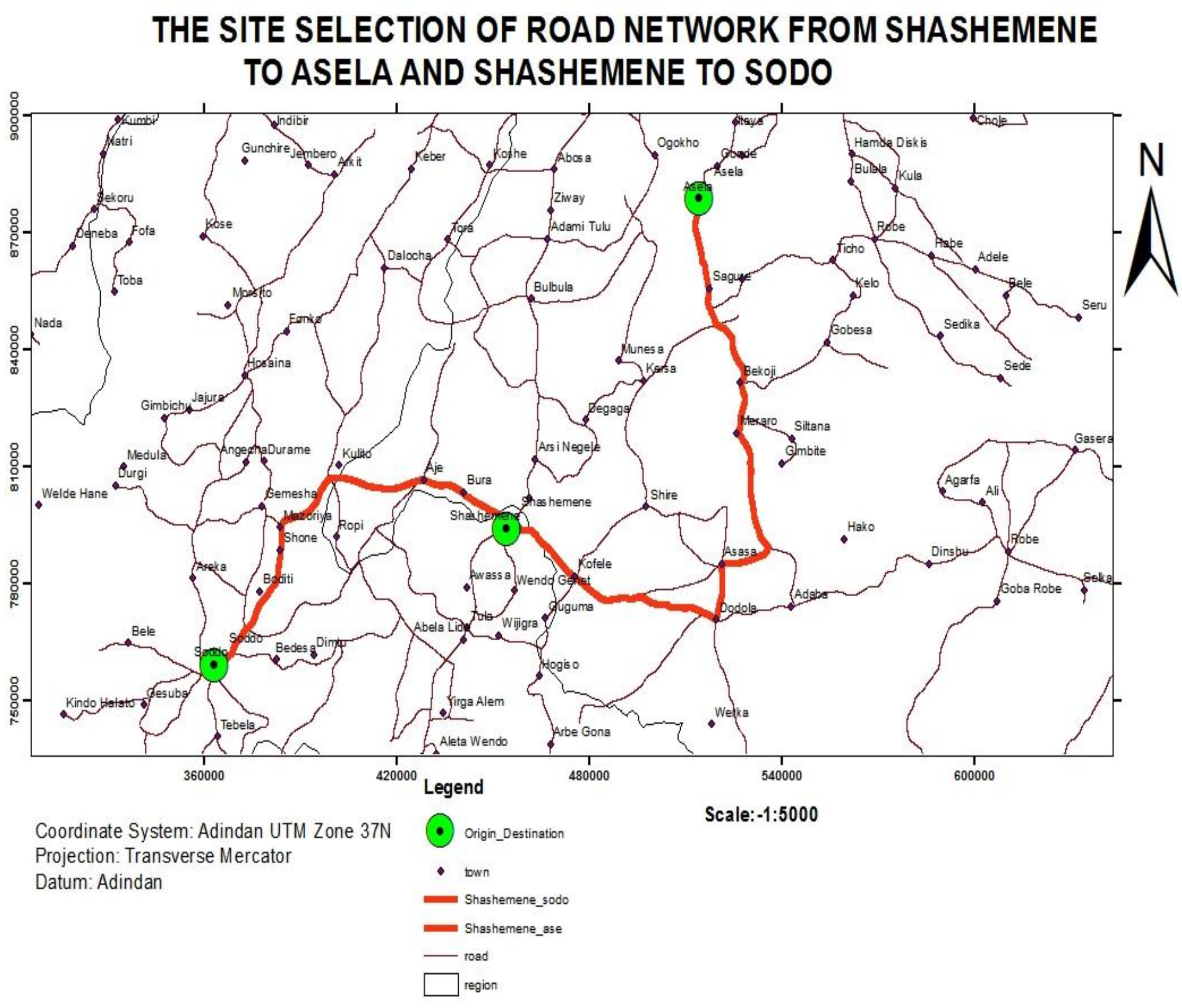

Figure 3.1: Source from Google map (map of date @2019).

Table 3.1The selection criteria developed to identify appropriate highway segments to be included in the study.

Selection characteristics	Criteria
AADT	300-1000
Zone descriptions	Rural
Posted speed limit	64km/h or higher
Terrain	Flat and rolling
Pavement condition	Surface in good condition
Pavement surface type	Flexible
Access control	No signal intersection
Cross section	Two-lane, one way
Slope	No restrictions

Source: (Didier, 2014)

Table 3. 2 No of sites by road segment.

Road segments	Number of sites
Shashemene –Asela	20
Shashemene - Wolaya Sodo	25
Total	45

Factors which influence the design consistency or the choice of driver's speed and considered to select design speed of geometric elements include:

1. Terrain (level, rolling, mountainous)
2. Driver expectations
3. Roadway classification
4. Traffic characteristics, volume, traffic composition and trip length
5. Environmental constraints
6. Land use and road surface
7. Speed limit and sight distance
8. Cross-section Markings
9. Guide signs and Rout markers
10. Geometry Signals
11. Warning and Regulatory signs

Considering the above factors, the roadway geometric elements data were obtained from design documents and through field measurements. These geometric characteristics included:-

1. Radius of horizontal curve
2. Length of horizontal curve
3. Tangent length
4. Super elevation of horizontal curve
5. Grade of horizontal curve and tangent
6. Speed Limit
7. Width of pavement and shoulder
8. Design speed

3.3 Data Collection and Sampling Techniques

3.3.1 The selection of Sampling Techniques and determined sample size

For this study would use the judgmental sampling, also called purposive sampling or authoritative sampling, and is a non-probability sampling technique in which the sample size are chosen only on the basis of the researcher knowledge judgment and his professional judgment. The process of selecting a sample using judgmental sampling involves the research carefully picking and choosing each individual to be a part of the sample. The researcher knowledge is primary in this sampling process as the members of the sample are not randomly chosen.

Expert judgmental picks useful cases for study and so, for this study sample size is consists of 45 simple horizontal curves and 45 tangents and used the Non - probability sampling techniques. Since Non- probability sampling represents a group of sampling techniques and has free distribution that help research to select a unite sampling from a population.

The selection of a purposive sample is often accomplished by applying expert knowledge of the population to select in a non-random manner a sample of elements that represents a cross-section of the population. This might involve selecting large (1000+ curves), medium (100-999 curves) and small (<100 curves) for the study of particular phenomena.

3.3.2 Data Collection

The necessary data for this research are primary and secondary data. The primary data would be colleted through site measurement which including the operating speed on tangent and simple horizontal curve, friction of demand on simple curves from the 85^{th} percentile operating speed , super elevation on simple horizontal curve, pavement width of curves and tangents and grade on tangent and curve section and the secondary data will be collet through reviewing the existing relevant document, report, literatures, which including the design guides and manuals, published journals and books, articles, the design document for selected roads.

Road geometric design variables were obtained from design plans of Ethiopia Road Authority (ERA) and field measurements. Field measurements were conducted to determine some geometric elements. The horizontal geometric elements included: degree of curvature, deflection angle, length of horizontal curve, grade of curve and tangent, super elevation, width of pavement and length of tangent and radius of horizontal curve. The field measurements included: grade of tangent and horizontal curve (%), super elevation of simple curve (%), width of pavement and operating speed (km/h).

The data collection at the site involves observing the operating speed and recording the speed of vehicles. The speeds were collected from three vehicle types: passenger cars, buses and trucks. The operating speed of the different types of vehicles was collected by observing the operating speed value using stopwatch method.

During the data collection, each site proposed was evaluated through a site visit where the geometric elements were checked and recorded. Free – flow Speed were measured using stopwatch method Free- flow vehicles were determined using a minimum headway of 5 second between vehicles (Lyinam, 200). Table 3.3 shows the characteristics of the sites.

Table 3.3 Characteristics of the sites

	Minimum	Maximum
Radius (m)	220	1000
Curve length (m)	107	795
Tangent length (m)	238	3500
Grade on horizontal curve (%)	0.125	8.875
Grade on tangent (%)	0.1	4.1
Total pavement width on H.c(m)	7	7.9
Total pavement width on tangent (m)	7	7.8
Super elevation on horizontal curves (%)	0.1	8.1

Speed measurements were taken at the half- length of the horizontal curve and at the half-length of the preceding tangent from the start of the preceding horizontal curve. The location for the speed measurements differed for each site because of the existing geometric and traffic control. The speeds were measured separately for three different vehicles types.

The 85^{th} percentile speed was determined for horizontal curves and tangent at each station (see appendix B). Consistency evaluation between simple circular curves and tangents and between design speed and operating speed was examined. A graphical analysis was performed to examine the trend for any relationship that may exist between the 85^{th} percentile speeds and geometric elements. After examining the data graphically, correlation analyses were performed. The correlation analyses were used to check the existence of relationship that may have been determined visually through the graphical analysis. The regression analysis determined which indices and geometric variable may be useful in combination to predict the desired speed of motorists. After all the possible relationship between the 85^{th} percentile speed and horizontal alignment elements were examined, an analysis of variance (ANOVA) was performed to determine if there were significant different in the observed 85^{th} percentile speed due to passenger cars, buses and trucks, All of the statistical analysis were performed using excel and were tested at a 95% percent confidence interval (i.e., significant level of a = 0.05 (see Appendix C).

3.4 The Research Design

The research design would be is based on a purposive sampling selection process in terms of which a representative sample of both tangent section and simple horizontal curve would be surveyed and the research would be conducted by using both field measurement and from the design plan. It means that the methodology used in the research would be a field measurement analysis of sample data tangent section and simple horizontal curve. All of the data would be collected from the site and from the road design plan. After comprehensively, organizing a literature review of different previous published journals, designate the influence of tangent section and simple horizontal curve elements on design consistency.

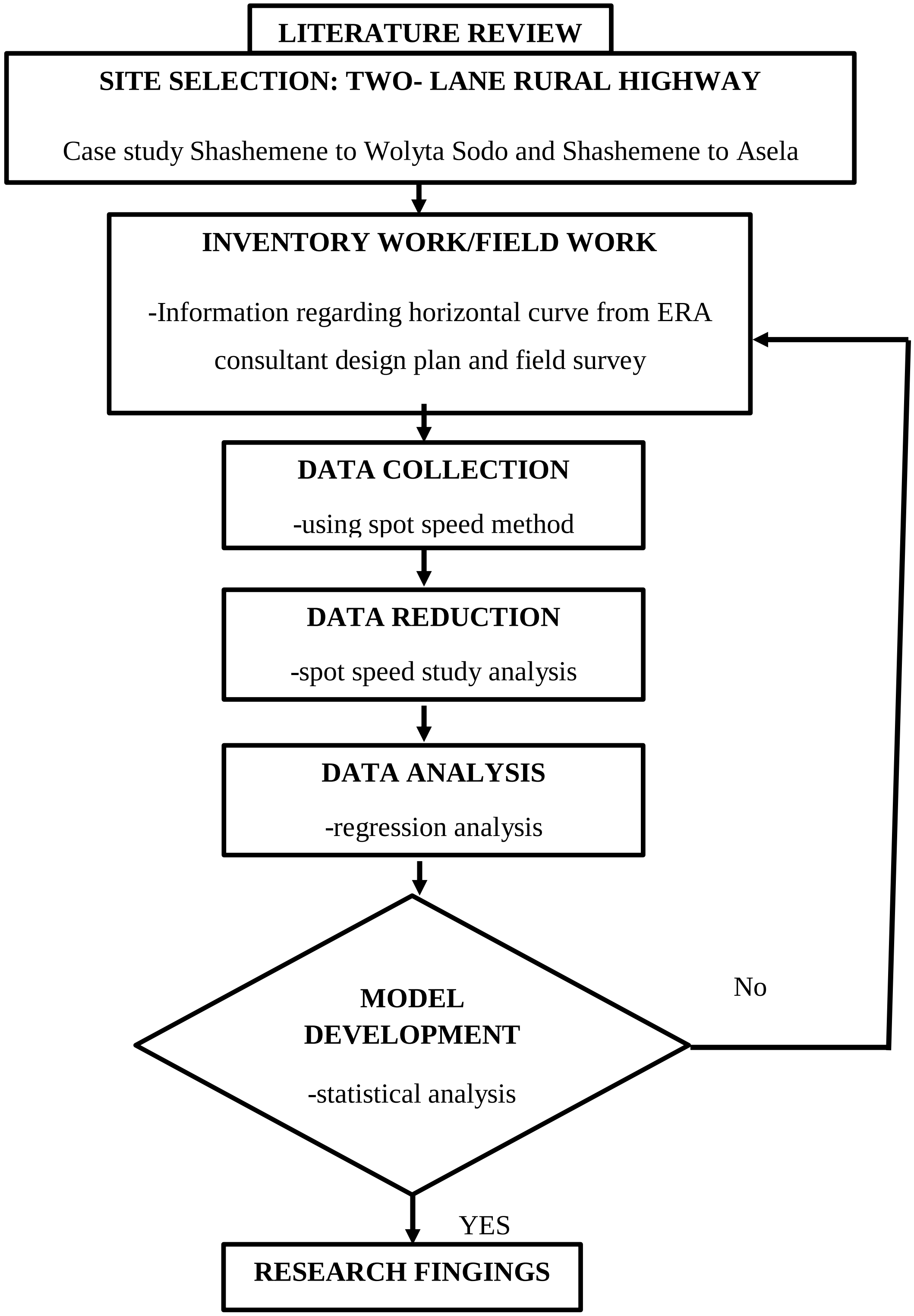

Figure 3.2: Flowchart of the research design process

3.5 Data Collection and Materials

3.5.1 Materials

The materials and software used for this research: SPSS to develop analysis statistical relation, digital camera and measuring tape, water leveling instrument, and stop watch.

3.5.2 Data Collection

Sites that have several different horizontal curve configuration and grade were selected for use in the evaluation of design consistency and the development of models for predicted the 85th percentile operating speed of passenger cars, buses and trucks traveling on horizontal curves and tangents section of the rural two-lane highways from Shashemene to Wolayta Sodo and Shashemene to Asela. The data collection had two man components: (1) geometric data of the site; and (2) speed data. Data were collected at 2 two-lane rural highway sites. A site comprised one direction of travel on all horizontal curves and its approach tangent. The data from 45 sites were used in evaluation of design consistency, model development and the 25 sites data were used to validate the developed models.

The selected two lane two-lane highway sites had good pavement condition with low traffic volume and few access points. The sites were not close to towns or developed areas where roadside condition might have adversely affected the operating speed of vehicles traveling on the curves and tangents.

3.5.2.1 Geometrical Data

It is well known that one of the major factors which affect the design consistency and traffic safety is the effect of road geometric consistency variation on the speed of traffic movement and mode of vehicular maneuver.

The geometric information was obtained from road construction plans collected from Ethiopia Road Authority Office (ERA) and through field measurements. For the horizontal curve, the data include; design speed (V_D), radius of circular curve (RC), length of circular curve (LC), super elevation (%), grade (%), degree of curvature (DC), deflection angle (DA), and widths of pavement and shoulder of curve. For the tangent, the data include; design speed (V_D), tangent length (TL), width of pavement and shoulder of tangent, grade on tangent (%), degree of successive curves, and deflection angles. These geometrical data are needed for the analysis and model development**.** The field measurements included; grade on tangents and curves, super elevation on horizontal curves, operating speed on horizontal curve and tangent and width of pavement. Table 3.4 summarizes the variable in data base and the source of the data.

Table 3.4 Independent variables consider in modeling 85th percentile speed on the midpoint of horizontal curves and tangents.

Independent variables	Source of Data	Curve	Tangent
Degree of Curve (%)	Plans	X	
Length of Curve(m)	Plans	X	
Deflection Angle (%)	Plans	X	
Super elevation (%)	Field	X	
Grade on curve and tangent (%)	Field	X	X
Radius of curve(m)	Plans	X	
Travel-Way Width (m)	Field	X	X
Tangent Length (m)	Plans	X	X
Total Pavement (Lane & Shoulder)Width(m)	Field	X	X
Operating Speed on Preceding Tangent (km/h)	Field		X
Operating Speed on Preceding Curve(km/h)	Field	X	
Terrain Type (Level or Rolling)	Field, Plans	X	X

3.5.2.2 Speed Data Measurements

In order to obtain information from vehicles those solely influenced by highway geometric characteristics and design consistency at selected locations of road segment used design speed obtain from the design document and operating speed from field measurements. The design speed defined as the maximum safe speed that can be maintained over a specified section of highway when condition are so favorable that the design features of the highway govern (AASHTO, 2011), and the operating speed is defined as the speed selected by drivers under free-flow condition, commonly taken as the 85^{th} percentile speed, i.e. the speed that 85% of drivers will not exceed (Poe and Mason, 2000). Operating speed measurements were taken at the half- length of the horizontal curve and on the half- length of the preceding tangent from the start of the horizontal curve. The location for the speed measurements differed for each site because of the existing geometry and traffic control. The speeds were measured separately for three different vehicles types: Passenger cars, Buses and Trucks (table 3.5).

Table 3.5 Vehicle classification by class

Passenger vehicles	Car	Cars and minibus
	land Rover	L. Rover, jeeps, Wagon and land cruiser
Buses	Small Buses	up to 27 passenger seats
	Large Buses	over 27 passengers seats
Trucks	Small and Light trucks	3.5 tons Load
	medium sized trucks	3.6 tons to 7.5 tons Load
	trucks and tankers	7.6 to 12 tons Load
	Truck trailers and tanker	Above 12 tons Load

Source: (Road asset management and contract implementation coordinate Directorate.1986)

Speed is an important transportation consideration because it relates to safety, time, comfort and convenience. Spot speed studies were used to determine the speed distribution of traffic stream at a specific location. The data gathered in spot speed were used to determine vehicle speed percentiles, which were useful in making many speed related decisions. Spot speed data have a number of safety application, including the following: (Robertson, 1994).

1. Determining existing traffic operations and evaluation of traffic control devices
2. Establishing roadway design elements
3. Assessing roadway safety questions
4. Monitoring traffic speed trends by systematic ongoing speed studies
5. Measuring effectiveness of traffic control devices or traffic program, including signs and marking, traffic operating changes, and speed enforcement programs.

For a spot speed study at a selected location, a sample size of at least 50 and preferably 100 vehicles is usually obtained (Ewing, 1999).Traffic counts during a Monday morning or a Friday peak period may show exceptionally high volumes and are not normally used in this study the analysis; therefore, in this study counts are usually conducted on a Tuesday, Wednesday, and Thursday. Spot speed data are gathered using one of three methods: (1) stopwatch, (2) radar meter method, or (3) pneumatic road tube method.

1. Stopwatch Method

The stopwatch method can be used to successfully complete a spot speed study using a small sample size taken over a relatively short of time. The stopwatch is a quick and inexpensive method for collected speed data. Spot speed data were gathered using stopwatch method. During the data collection in stopwatch spot speed study five key steps were used:

1. Appropriate study length was obtained using posted speed limit which was > 81m
2. Proper location and layout was selected.
3. The elapse time observation data was recorded on stopwatch form.
4. Vehicle speeds were calculated.
5. The frequency distribution table was generated for each station and 85^{th} speed percentiles were determined.

1. Obtain Appropriate Study Length to measure operating speed

The study length is important because it was used in the calculation of vehicle speeds. Table 3.6 provides recommended study lengths, which were based on the average speed of the traffic stream.

Using these recommended study lengths made speed calculation straight forwarded and was less confusing. If these lengths are not appropriate, another length can be used assuming it is long enough for reliable observer reaction times.

Table 3.6 Recommended spot speed study length.

Traffic Stream Average Speed	Recommended study length (m)
Below 40km/h	27
40-64.4km/h	54
Above 64.4km/h	81

Source :(Handbook of Simplified Practice for Traffic studies, 2002)

1.1 Select proper location and layout

Figure 3.4 illustrates a typical for conducting a spot speed study using a stopwatch. When selected a location and layout, care must be exercised so that the observer can clearly see any vertical reference post. The observer should be position than the study area and be looking down. The observer should use reference point to aid in collecting the elapsed time it takes a vehicle to travel through the area. The reference point to start timing might be brightly colored vertical post. The reference point to end timing might be tree or a signpost in observer's sight line.

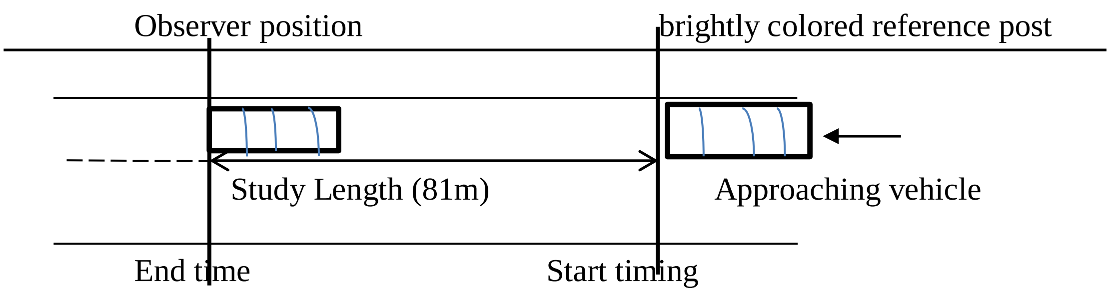

Figure 3.3 Stopwatch Spot Speed Study Layouts on tangent section

2. Record observations on stopwatch spot speed data form

On the stopwatch spot speed data form, the observer recorded the date, location, posted speed limit, weather condition, start time, end time and down time. As the front wheels of a vehicle (or only the lead vehicle in group) crossed a mark of the predetermined study length, the observer started the stopwatch. The watch was stopped when the vehicle's front wheels passed a reference line in front of the observer. A slash was recorded on the data form corresponding to the elapsed time observed. The collected data were in (appendix A).

3. Calculate Vehicle Speeds

To calculate vehicle speed, use the predetermined study length and the elapsed time it took the vehicle to move the course (as recorded on the stopwatch data form) in the following formula (Robertson, 1994):

$V = \frac{D}{T}$ x 3.6 (km/h) or $\frac{D}{T}$x1.47 (m/h) ………………………………………. (Equation, 3.1)

Where V = spot speed (m/s), D = length (m) of (tangent or LC), and T = elapsed time (sec). In equation (3.1), 3.6 is a constant that converts units of meter per second into kilometer per hour. The data observed and calculated values were present in appendix A.

4. Operating Speed Percentiles

Operating Speed percentiles were tools used to determine and adequate speed limits and to consider the operating speed during the design time for the Ethiopian Road Authority. The two speed percentiles most important to understand are the 50th and 85th percentiles. The 50th percentile is the median speed of the observed data set. This percentile represents the speed at which half of the observed are below and half of the observed vehicles are above.

The 85th percentile was the speed at which 85% of the observed were traveling at or below of 85th percentile speed. This percentile was used in evaluating or recommending posted speed limit and to consider the operating speed during the design time for the Ethiopian Road Authority based on the assumption that 85% of the drivers were traveling at a speed they perceive to be safe (Homburger et al., 1996).In other words, the 85th percentile of speed was normally assumed to be the highest safe speed for a roadway section. Using the 85th percentile operating speed was used to evaluate design consistency of the road alignments.

3.6 Sample Size of Operating Speed

The minimum sample size required to estimate a variable with an accuracy of ±Ɛ Unites at a certain confidence level were stated below.

The speed variable was normally distributed and a large sample (≥ 30) was available to calculate the standard deviation, the Z- statistic can be used instead of the t statistic. There are other methods available which approximate the equation below using certain assumptions and are easier to work with.

Use of the z-statistic in place of the t – statistic is also suggested for ease of calculation, and an adjustment factor was introduced to balance the discrepancy. The “modified” equation is (3.2):

$$n = \left(\frac{z \times \sigma}{\varepsilon}\right)^2 + \varepsilon_n \qquad \text{(Equation,3.2)}$$

Based on numerical results, the value ε_n recommended as 2, 3 and 4 for confidence levels 90%, 95%, and 99%, respectively. Another work suggested a constant value of ε_n 2 for in situations with less than 30 observations.

A minimum of 100 free-flow vehicles was desire for each study site. This sample size was determined by the following equation (3.3) (Garber & Hoel, 2009).

$$N = \left(\frac{s\,x k}{E}\right)^{2+\varepsilon_n} \qquad \text{(Equation, 3.3)}$$

Where: N =number of measured speeds, S = estimated sample standard deviation in (km/h),

K = constant corresponding to the desired confidence level and E = permitted error in the speed estimate in (km/h).

Standard deviation = 8.046km/h, Acceptable confidence level = 95% and

Permitted error = 1.609km/h

The value of k at 95% is 1.96 using this value the sample size were N= 100 per each curves.

The data of operating speed were obtained after collecting of speed at each location of road segment that was identified for this study was described in (appendix A).

3.7 Method of data processes and analyses

The method data processing and analyzing were used graphical analyses, table, and excel, SPSS statistics software and mathematical equation. The graphical analysis was performed to examine the trend for any relationship that may exist between the 85th percentile operating and horizontal geometric elements, the excel was processing the gathered data and graphs, the table was used to organized the data, SPSS statistics software was used for the regression results and correlation of variable and the mathematical equation was used to computed the mathematical analyses.

4. RESULTS AND DISCUSSIONS

4.1 Evaluation of design consistency

4.1.1 Evaluation of Design Consistency between simple circular curve and tangent section

In this study used the road section of simple curve and tangent were taken for design consisten cy evaluation. After determining the 85^{th} percentile operating speed for simple circular curve and tangent section, evaluation was performed for the consecutive road section using the following criteria's

Good Design: The change in the degree of curve is ≤ deg and the change in operating speed V85 is less than or equal to 10km/h between successive design elements.

Fair Design: The change in the degree of curve is 5 < DC ≤ 10 deg and the change in operatin g speed 10km/h < V85 ≤ 20km/h between successive design elements.

Poor Design: The change in the degree of curve is > 10 deg and the change in operating speed V85 > 20km/ between successive design elements.

Table 4.1 Design Consistency between Simple Circular Curve and Tangent, for V_{85} percentile operating speed.

Road	Stations	V_{85}^{th} on curve km/r	V_{85}^{th} on tangent (km/r)	Δ in V_{85} km/h	ΔV_{85} < 10 km/h	10<ΔV_{85}≤ 20 km/h	ΔV_{85}>20km/h
Shashemene to Wolayta Sodo	2+249-2+871	86	116	30			Poor
	4+757-5+927	111	109	2	Good		
	8+878-9+178	104	111	7	Good		
	10+382-10+627	92	102	10	Good		
	13+558-13+900	91	98	7	Good		
	15+108-16+903	79	112	33			Poor
	17+795-19+375	97	96	1	Good		
	22+828-23+830	72	89	17		Fair	
	26+064-26+474	89	102	13		Fair	
	28+209-28+669	69	110	41			Poor
	31+279-31+739	83	102	19		Fair	
	33+886-34+446	106	89	17		Fair	

	36+863-37+285	87	109	22			Poor
	37+723-39+270	92	116	24			Poor
	40+834-41+407	66	113	47			Poor
	43+126-43+956	78	112	34			Poor
	44+664-45+724	79	121	42			Poor
	47+594-49+176	108	117	9	Good		
	52+841-54+171	73	97	24		Fair	
	55+431-56+621	69	95	26			Poor
	57+428-57+918	76	108	32			Poor
	58+729-59+433	84	79	5	Good		
	65+056-66+471	94	114	20		fair	
	72+912-73+173	83	109	26			Poor
	82+982-83+459	81	95	14		Fair	
	120+325-121+107	73	89	16		Fair	
Shashemene to Asela	3+431-3+818	87	118	31			Poor
	5+521-6+405	99	115	16		Fair	
	9+203-11+054	89	87	2	Good		
	13+140-13+436	110	86	24			Poor
	18+699-20+657	101	110	9	Good		
	31+631-31+906	91	119	28			Poor
	37+773-38+152	89	120	31			Poor
	41+494-41+899	97	107	10	Good		
	52+421-52+956	91	101	10	Good		
	62+007-62+331	93	106	13		Fair	
	81+374-81+734	76	96	20			Poor
	83+072-83+462	110	114	4		Fair	
	102+404-102+820	78	123	45			Poor
	122+634-123+634	86	115	29			Poor
	123+384-123+877	92	103	11		Fair	
	127+251-128+131	104	105	1	Good		
	128+986-129+455	78	103	25			Poor
	130+988-131+479	87	110	23			Poor
	123+165-143+777	97	95	2	Good		

In table 4.1 the apparent relationship obtained between 85th percentile operating speed tangent section and 85th percentiles operating speed for horizontal circular curves sections results shown that of design consistency evaluation between simple circular curve and tangent section results shown that thirteen sections were under good condition, twelve sections were under fair section and twenty sections were under poor condition. This shows that highly design inconsistency exist in this study area of two-lane rural highways roads. The results shows that the 29% the difference between the 85th percentile operating speed of tangent and 85th percentile operating speed of curves less than 10km/h, 27% of the difference between the 85th percentile operating speed of tangent and 85th percentile operating speed of curves was greater than 10km/h and less than 20km/h and 44% the difference between the 85th percentile operating speed of tangent and 85th percentile operating speed of curves was greater than 20km/h. This shown that there are a series problem of design inconsistency between the tangent and curves section in this study area of the rural two-lane highway road and therefore it requires series consideration by the Ethiopia Roads Authority in order to avoid the accidents and / or the safety problem at the curves section that may occur on the roads due to design inconsistency.

4.1.2 Design Consistency Evaluation between Design Speed and Operating Speed

Evaluation was performed between design speed used for design and existing 85th operating speed of road segments and the design speed got from the road design.

The following criteria were used for the evaluation of design consistency.

Good Design: The difference between the operating speed and design speeds is less than or equal to 10km/h for the investigated curve or tangent**.**

Good Fair: The difference between the operating speed and design speeds is 10km/h < V85 – Vd ≤ 2okm/h for the investigated curve or tangent.

Good Design: The difference between the operating speed and design speeds is > 20km/h for the investigated curve or tangent.

Table 4.2 Design consistency evaluation between design speeds and operating on horizontal curves

Road	Stations	V_{85}^{th} on curve km/hr	Design Speed km/h	$\lvert V_{85}-V_D \rvert$ km/h	$\lvert V_{85}-V_D \rvert$ < 10km/h	$10 < \lvert V_{85}-V_D \rvert \leq 20$ km/h	$\lvert V_{85}-V_D \rvert$ > 20km/h
Shashemene to Wolayta Sodo	2+127 - 2+371	86	70	16		Fair	
	4+412 - 5+102	111	70	21			Poor
	8+744 - 9+012	104	70	34			Poor
	10+262 -10+502	92	85	7	Good		
	13+485 - 13+630	91	85	5	Good		
	14+995-15+220	79	85	6	Good		
	17+645 - 17+945	97	85	12		Fair	
	22+430-23+225	72	85	13		Fair	
	25+979-26+149	89	70	19		Fair	
	28+099-28+319	69	70	1	Good		
	31+119-31+439	83	70	13		Fair	
	33+726-34+046	106	70	36			Poor
	36+790-36+935	87	85	2	Good		
	37+635-37+810	92	85	7	Good		
	40+706-40+962	66	85	19		Fair	
	42+826-43+426	78	70	8	Good		
	44+486-44+841	79	70	9	Good		
	47+261-47+926	108	70	38			Poor
	52+691-52+991	73	85	12		Fair	
	55+351-55+511	69	85	16		Fair	
	57+318-57+528	76	85	9	Good		
	58+308-59+150	84	70	14		Fair	
	64+731-65+381	94	70	24			Poor
	72+801-73+023	83	70	13		Fair	
	82+769-83+199	81	70	7	Good		
	120+263-120+387	73	70	4	Good		
Shashemene to Asela	3+306-3+556	87	70	17		Fair	
	5+462-5+580	99	70	29			Poor
	9+147-9+259	89	85	4	Good		
	13+071-13+208	110	85	25			Poor
	18+321-18+746	101	85	16		Fair	
	31+571-31+690	91	85	6	Good		
	37+680-37+865	89	85	4	Good		
	41+406-41+582	97	85	12		Fair	
	52+253-52+588	91	85	6	Good		
	61+880-62+133	93	85	8	Good		
	81+249-81+499	76	85	9	Good		
	82+968-83+176	110	70	40			Poor

	102+306-102+502	78	70	8	Good		
	122+484-122+784	86	70	16		Fair	
	123+284-123+484	92	70	22		Fair	
	127+131-127+370	104	70	34			Poor
	128+891-129+080	78	85	7	Good		
	130+804-131+171	87	85	2	Good		
	142+892-143+438	97	85	12		Fair	

In table 4.2 the apparent relationship obtained between design speed and 85th percentiles operating speed for horizontal circular curves sections shown that the difference between the design speed and 85th percentile operating speed results shown that twenty sections were under good condition, sixteen sections were under fair section and nine sections were under poor condition. This shows that highly design inconsistency exist in this study area of two-lane rural highways roads. The results shows that the 44% the difference between the design speed and 85th percentile operating speed less than 10km/h, 36% of the difference between the design speed and 85th percentile operating speed was greater than 10km/h and less than 20km/h and 20% the difference between the design speed and 85th percentile operating speed was greater than 20km/h. This shown that there are a series 20% problem of design inconsistency in this study area of the rural two-lane highway road and therefore it requires series consideration by the Ethiopia Roads Authority in order to avoid the accidents and / or the safety problem at the curves section that may occur on the roads due to design inconsistency.

Table 4.3 Design consistency evaluation between design speeds and operating speed of tangent section

Road	Stations	V_{85}^{th} on tangent km/r	Design Speed km/h	$\lvert V_{85}-V_D \rvert$ km/h	$\lvert V_{85}-V_D \rvert$ < 10km/h	$10 < \lvert V_{85}-V_D \rvert \leq 20$ km/h	$\lvert V_{85}-V_D \rvert$ > 20km/h
Shashemene to Wolayta Sodo	2+371-3+371	116	70	46			Poor
	5+102-6+752	109	70	39			Poor
	9+012-9+344	111	70	41			Poor
	10+502-10+752	102	85	17		Fair	
	13+630-14+170	98	85	13		Fair	
	15+220-16+585	112	85	27			Poor
	17+945-20+805	96	85	11			Poor
	23+225-24+435	89	85	4	Good		

	26+149-26+799	102	70	32			Poor
	28+319-29+019	110	70	40			Poor
	31+439-32+039	102	70	32			
	34+046-34+846	89	70	19		Fair	
	36+935-37+635	109	85	24			Poor
	37+810-39+270	116	85	31			Poor
	40+962-41+552	113	85	28			Poor
	43+426-44+486	112	70	42			Poor
	44+841-46+306	121	70	51			Poor
	47+926-50+426	117	70	47			Poor
	52+991-55+351	97	85	12		Fair	Poor
	55+511-56+731	95	85	10	Good		
	57+528-58+308	108	85	23			Poor
	59+150-59+715	79	70	9	Good		
	65+381-67+561	114	70	44			Poor
	73+023-73+323	109	70	39			Poor
	83+194-83+724	95	70	25			Poor
	120+387-121+827	89	70	19		Fair	
Shashemene to Asela	3+556-4+079	118	70	48			Poor
	5+580-7+230	115	70	45			Poor
	9+259-12+849	87	85	2		Fair	
	13+208-13+664	86	85	1		Fair	
	18+746-22+567	110	85	25			Poor
	31+690-32+121	119	85	34			Poor
	37+8653-38+439	120	85	35			Poor
	41+582-42+217	107	85	22			Poor
	52+588-53+324	101	85	16		Fair	
	62+133-62+528	106	85	21			Poor
	81+499-82+968	96	85	11		Fair	
	83+176-83+748	114	70	44			Poor
	102+502-103+137	123	70	53			Poor
	122+784-123+284	115	70	45			Poor
	123+484-124+264	103	70	33			Poor
	127+370-128+891	105	70	35			Poor
	129+080-129+830	103	85	18		Fair	
	131+171-131+771	110	85	25			Poor
	143+438-144+116	95	85	10	Good		

In table 4.3 the apparent relationship obtained between design speed and 85th percentile operating speed at tangent sections shown that four sections were under good condition, ten sections were under fair section and thirty one sections were under poor condition. This shows that highly inconsistency design exist in this study area of rural two-lane highways roads. The results shows the 69% 85th percentile operating speed observed was greater by 20km/h from the design speed, 22% 85th percentile operating speed observed was greater than ten and less than twenty km/h and 9% 85th percentile operating speed observed was less than ten km/h. This results shown that there are a series 67% problem of design inconsistency between design speed and 85th percentile operating speed of tangents section in this study area of rural two-lane highways roads and therefore it requires series consideration by the Ethiopia Roads Authority in order to avoid the accidents and /or safety problem that may occur on the roads due to design inconsistency.

4.1.3 Evaluation of Design Consistency between Side Friction Assumed and Side Friction Demanded

After determining the 85th percentile operating speed for simple circular curves, evaluation of design consistency between side frictions assumed ($f_{RA,}$ that depends on design speed) and side friction demanded ($f_{RD,}$ that depends on the V85 percentile operating speed). For consistency Evaluation was based on vehicle stability the following criteria's have shown hereafter:

Good Design: The change side friction demanded and side friction assumed is greater than or equal to 0.01 ($\Delta f_R \geq 0.01$).

Fair Design: The change side friction demanded and side friction assumed is less than the 0.01 and greater or equal to -0.04 ($-0.04 < \Delta f_R < 0.01$).

Poor Design: The change side friction demanded and side friction assumed is less than -0.04 ($\Delta f_{R<}$ -0.04).

Table 4.4 Design consistency evaluations between side friction assumed and side friction demanded on horizontal curves

Road	Stations	V_{85}^{th} on curve km/h	Design Speed km/h	$\vert f_{RA} - f_{RD}\vert$	$\vert f_{RA} - f_{RD}\vert \geq 0.01$	$-0.04 < \vert f_{RA} - f_{RD}\vert \leq 0.01$	$\vert f_{RA} - f_{RD}\vert < -0.04$
Shashemene to Wolayta Sodo	2+127 - 2+371	86	70	-0.081			Poor
	4+412 - 5+102	111	70	-0.18			Poor
	8+744 - 9+012	104	70	-0.124			Poor
	10+262 -10+502	92	85	-0.031		Fair	
	13+485 - 13+630	91	85	-0.002		Fair	
	14+995-15+220	79	85	0.008		Fair	
	17+645 - 17+945	97	85	-0.046			Poor
	22+430-23+225	72	85	0.048	Good		
	25+979-26+149	89	70	-0.08			Poor
	28+099-28+319	69	70	-0.037		Fair	
	31+119-31+439	83	70	-0.076			Poor
	33+726-34+046	106	70	-0.125			Poor
	36+790-36+935	87	85	-0.047			Poor
	37+635-37+810	92	85	-0.05			Poor
	40+706-40+962	66	85	0.003		Fair	
	42+826-43+426	78	70	-0.054			Poor
	44+486-44+841	79	70	-0.073			Poor
	47+261-47+926	108	70	-0.153			Poor
	52+691-52+991	73	85	-0.008		Fair	
	55+351-55+511	69	85	0.004		Fair	
	57+318-57+528	76	85	-0.002		Fair	
	58+308-59+150	84	70	-0.123			Poor
	64+731-65+381	94	70	-0.165			Poor
	72+801-73+023	83	70	-0.053			Poor
	82+769-83+199	81	70	-0.055			Poor
	120+263-120+387	73	70	-0.072			Poor
Shashemen to Asela	3+306-3+556	87	70	-0.041		Fair	
	5+462-5+580	99	70	-0.091			Poor
	9+147-9+259	89	85	-0.041		Fair	
	13+071-13+208	110	85	-0.131			Poor
	18+321-18+746	101	85	-0.131			Poor
	31+571-31+690	91	85	-0.028		Fair	
	37+680-37+865	89	85	-0.034		Fair	
	41+406-41+582	97	85	-0.076			Poor
	52+253-52+588	91	85	-0.045			Poor
	61+880-62+133	93	85	-0.003		Fair	
	81+249-81+499	76	85	0.052	Good		
	82+968-83+176	110	70	-0.121			Poor
	102+306-102+502	78	70	-0.058			Poor

	122+484-122+784	86	70	-0.075			Poor
	123+284-123+484	92	70	-0.025		Fair	
	127+131-127+370	104	70	-0.065			Poor
	128+891-129+080	78	85	0.051	Good		
	130+804-131+171	87	85	0.035	Good		
	142+892-143+438	97	85	-0.108			Poor

In table 4.4 the apparent relationship obtained between design speed and 85th percentiles operating speed for circular curves sections that is the change of side friction supplied /assumed and side friction demanded results shows that four sections were under good condition, fourteen sections were under fair section and twenty seven sections were under poor condition. This shows that highly inconsistency design exist in this study area of two-lane rural highways roads. The results shows that the 60% of change side friction assumed and side friction demanded less than -0.04 from the design speed, 31% change of side friction assumed and side friction demanded between the 0.01 and -0.04 and 9% change of side friction assumed and side friction demanded greater than 0.01 this shown that there are a 60% series problem of design inconsistency in this study area of the rural two-lane highway road and therefore it requires series consideration by the Ethiopia Roads Authority in order to avoid the accidents and / or the stability problem at the curves section that may occur on the roads due to design inconsistency.

4.1.4 Examination of Geometric Elements as Individual Estimators of Desired Speed.

Data would be collected for the analysis is obtained from design documents and through field measurements have shown different characteristics. Grade of curves, radius of curves, length of curves and super elevation would be used for the analysis of operating on curves and tangent length, pavement width, grade of tangent were would be used for the analysis of operating speed on tangent section. Length of curve, radius of curve, tangent length found from the design documents, Whereas, super elevation, grade of tangent and curve, total pavement width and operating speed would be measured from field observations.

After operating speed was measured the average speed, standard deviation, variance and 85th percentile speed were determine for each type of vehicle category at individual stations. Table 4.5 and table 4.6 shows operating speed characteristics on curves and tangent sections.

Table 4.5 Operating speed characteristics on curves

Operating speed characteristics on curves											
Cars				Buses				Trucks			
Avg	Std	Var	V85th	Avg	Std	Var	V85th	Avg	Std	Var	V85th
89	12	576	125	89	12	576	125	89	12	576	113
100	13	546	130	100	13	546	130	100	13	546	115
110	25	456	130	110	25	456	130	110	25	456	104
99	26	256	125	99	26	256	125	99	26	256	110
98	21	230	112	98	21	230	112	98	21	230	117
89	14	254	99	89	14	254	99	89	14	254	106
116	17	200	121	116	17	200	121	116	17	200	127
115	18	253	118	115	18	0	118	115	18	0	109
114	17	325	116	114	17	325	116	114	17	325	110
100	16	412	109	100	16	412	109	100	16	412	109
96	18	450	125	96	18	450	125	96	18	450	110
89	21	421	131	89	21	421	131	89	21	421	112
92	23	510	117	92	23	510	117	92	23	510	116
91	22	412	116	91	22	412	116	91	22	412	127
93	19	420	115	93	19	420	115	93	19	420	105
97	15	562	89	97	15	562	89	97	15	562	127
97	4	623	99	97	4	623	99	97	4	623	104
98	18	560	124	98	18	560	124	98	18	560	108
91	14	289	108	91	14	289	108	91	14	289	110
111	16	278	106	111	16	278	106	111	16	278	105
110	23	510	114	110	23	510	114	110	23	510	106
120	25	451	113	120	25	451	113	120	25	451	107
87	24	231	120	87	24	231	120	87	24	231	105
96	26	365	106	96	26	365	106	96	26	365	115
89	2	304	100	89	2	304	100	89	2	304	110
121	28	576	114	121	28	576	114	121	28	576	110
108	21	421	99	108	21	421	99	108	21	421	110
114	27	586	121	114	27	586	121	114	27	586	114
113	22	442	116	113	22	442	116	113	22	442	115
112	22	236	124	112	22	236	124	112	22	236	116
100	23	256	118	100	23	256	118	100	23	256	115
99	24	241	116	99	24	241	116	99	24	241	115
102	23	289	109	102	23	289	109	102	23	289	119
102	24	540	113	102	24	540	113	102	24	540	119
79	25	530	89	79	25	530	89	79	25	530	121
103	26	481	123	103	26	481	123	103	26	481	110
102	23	526	115	102	23	526	115	102	23	526	107
95	21	430	95	95	21	430	95	95	21	430	125

87	20	452	114	87	20	452	114	87	20	452	116
98	20	602	102	98	20	602	102	98	20	602	115
86	23	562	113	86	23	562	113	86	23	562	113
89	27	531	120	89	27	531	120	89	27	531	113
87	24	456	102	89	20	493	103	87	25	531	121
99	22	463	99	105	24	423	116	95	23	450	115

Considering the results of the operating speed characteristics a t-test was made in order to find whether the 85th percentile speed of passenger cars, buses and trucks were significantly different. Table 4.6 to table 4.7 shows the result of t-test for each vehicle category in curves.

Horizontal curve – cars and buses

t-Test: Paired two sample for means

Table 4.6 t-Test for operating speed of passenger cars and buses

	Variable 2	Variable 2
Mean	128.953488	115.55814
Variance	342.664452	221.39535
Observations	45	45
Pearson Correlation	0.81456639	
Hypothesized Mean Difference	0	
df	45	
t Stat	8.17896451	
P(T<=t) one-tail	1.58E-10	
t Critical one-tail	1.68195236	
P(T<=t) two-tail	3.15E-10	

Horizontal curve – cars and trucks

t-Test: Paired two sample for means

Table 4.7 t-Test for operating speed of passenger cars and trucks

	Variable 1	Variable 2
Mean	128.9534884	115.395349
Variance	342.6644518	304.578073
Observations	45	45
Pearson Correlation	0.817537503	
Hypothesized Mean Difference	0	
Df	45	
t Stat	8.149567809	
P(T<=t) one-tail	1.73E-10	
t Critical one-tail	1.681952358	
P(T<=t) two-tail	3.46E-10	
t Critical two-tail	2.018081679	

Table 4.8 operating speed characteristics on tangents

Operating speed characteristics on tangents											
Cars				Buses				Trucks			
Avg	Std	Var	V85th	Avg	Std	Var	V85th	Avg	Std	Var	V85th
89	12	576	125	89	12	576	125	89	12	576	126
100	13	546	130	100	13	546	130	100	13	546	127
110	25	456	130	110	25	456	130	110	25	456	123
99	26	256	125	99	26	256	125	99	26	256	125
98	21	230	112	98	21	230	112	98	21	230	126
89	14	254	99	89	14	254	99	89	14	254	126
116	17	200	121	116	17	200	121	116	17	200	122
115	18	251	118	115	18	320	118	115	18	250	126
114	17	325	116	114	17	325	116	114	17	325	126
100	16	412	109	100	16	412	109	100	16	412	126
96	18	450	125	96	18	450	125	96	18	450	125
89	21	421	131	89	21	421	131	89	21	421	127
92	23	510	117	92	23	510	117	92	23	510	127
91	22	412	116	91	22	412	116	91	22	412	127
93	19	420	115	93	19	420	115	93	19	420	124
97	15	562	89	97	15	562	89	97	15	562	125
97	4	623	99	97	4	623	99	97	4	623	125
98	18	560	124	98	18	560	124	98	18	560	125
91	14	289	108	91	14	289	108	91	14	289	126
111	16	278	106	111	16	278	106	111	16	278	126
110	23	510	114	110	23	510	114	110	23	510	127
120	25	451	113	120	25	451	113	120	25	451	127
87	24	231	120	87	24	231	120	87	24	231	127
96	26	365	106	96	26	365	106	96	26	365	129
89	2	304	100	89	2	304	100	89	2	304	129
121	28	576	114	121	28	576	114	121	28	576	129
108	21	421	99	108	21	421	99	108	21	421	127
114	27	586	121	114	27	586	121	114	27	586	128
113	22	442	116	113	22	442	116	113	22	442	128
112	22	236	124	112	22	236	124	112	22	236	127
100	23	256	118	100	23	256	118	100	23	256	127
99	24	241	116	99	24	241	116	99	24	241	127
102	23	289	109	102	23	289	109	102	23	289	126
102	24	540	113	102	24	540	113	102	24	540	127
79	25	530	89	79	25	530	89	79	25	530	127
103	26	481	123	103	26	481	123	103	26	481	126
102	23	526	115	102	23	526	115	102	23	526	125
95	21	430	95	95	21	430	95	95	21	430	126
87	20	452	114	87	20	452	114	87	20	452	126
98	20	602	102	98	20	602	102	98	20	602	126

86	23	562	113	86	23	562	113	86	23	562	127
89	27	531	120	89	27	531	120	89	27	531	126
101	25	465	103	92	25	514	115	89	24	127	110
87	20	512	110	86	24	516	117	103	27	127	116

Considering the results of the operating speed characteristics a t-test was made in order to find whether the 85th percentile speed of passenger cars, buses and trucks were significantly different or not. Table 4.9 to table 4.10 shows the result of t-test for each vehicle category in tangent.

Tangent – cars and Buses

t-Test: Paired two sample for means

Table 4.9 t-Test for operating speed of passenger cars and Buses

	Variable 1	Variable 2
Mean	127.511628	116.3953488
Variance	244.017719	151.8161683
Observations	45	45
Pearson Correlation	0.579587	
Hypothesized Mean Difference	0	
Df	45	
t Stat	5.54647434	
P(T<=t) one-tail	8.89E-07	
t Critical one-tail	1.68195236	
P(T<=t) two-tail	1.78E-06	
t Critical two-tail	2.01808168	

Tangent – cars and Trucks

t-Test: Paired two sample for means

Table 4.10 t-Test for operating speed of passenger cars and trucks

	Variable 1	Variable 2
Mean	127.5116279	116.0465116
Variance	244.0177187	190.6168328
Observations	45	45
Pearson Correlation	0.502637441	
Hypothesized Mean Difference	0	
df	45	
t Stat	5.093985431	
P(T<=t) one-tail	3.92E-06	
t Critical one-tail	1.681952358	

P(T<=t) two-tail	7.84E-06	
t Critical two-tail	2.018081679	

4.1.5 Graphical Analysis

The influence of geometric features on the 85th percentile speed on curves and tangents was first examined graphically. For the entire geometric element stated in table 4.11 and 4.12, graphs of the observed 85th percentile speeds against the geometric elements were developed. The graphs, which are shown in figures 4.1 to 4.8, were plotted in order to visually examine those geometric elements that may assure in estimating the desired speed of motorists on horizontal curves and tangents.

Table 4. 11 Geometric elements and 85th operating speed on horizontal curves.

Station (km)	Radius(m)	Total pavement Width	Grade (%)	Super elevatio n (%)	Curve Le ngth (m)	85th Speed (km/h)
2+249	540	7.5	3.3	3.3	244	113
4+757	360	7.5	1.6	6.1	690	115
8+878	900	7.5	2	0.1	268	104
10+382	600	7.5	2.1	4.3	240	110
13+558	800	7.5	2.5	5.1	301	117
15+108	360	7.5	0.1	3.5	145	106
17+795	950	7.5	0.1	3.9	225	127
22+828	360	7	2.5	7.6	300	109
26+064	400	7	0.8	4.6	795	110
28+209	600	7	1.1	4.1	170	109
31+279	450	7.9	1.3	3.9	220	110
33+886	580	7.7	1.2	4.1	320	112
36+863	400	7.6	1.1	3.9	320	116
37+723	900	7	1.1	4.1	145	127
40+834	550	7	1.3	4.1	175	105
43+126	600	7.8	0.3	3.5	256	127
44+664	570	7	1.5	2.5	145	104
47+594	460	7.4	0.3	4.3	175	108
52+841	540	7.4	0.7	4.4	256	110
55+431	1000	7.6	0.8	6.1	600	105
57+428	360	7.4	0.5	4.6	355	106
58+729	220	7.3	0.6	3.4	665	107
65+056	220	7.4	0.4	4.3	300	105
72+912	425	7.3	2.1	6.2	160	115
82+982	425	7.1	0.1	5.6	210	110

120+325	300	7.2	0.5	1.9	842	110
3+431	500	72	0.3	6.9	650	110
5+521	500	7.6	1.1	5.3	222	114
9+203	200	7.8	2.1	6.6	425	115
13+140	600	7.7	0.3	1.3	124	116
18+699	190	7.5	1.4	7.1	250	115
31+631	600	7.5	1.4	6.6	118	115
37+773	375	7.4	4.3	6.1	112	119
41+494	300	7.9	0.1	6.1	137	119
52+421	275	7.5	3.8	6.5	155	121
62+007	750	7.4	4.1	6.9	119	110
81+374	230	7.4	3.5	5.9	185	107
83+072	580	7.9	2	4.5	176	125
102+404	230	7.8	1.3	6.3	335	116
122+364	230	7.5	2.4	5.9	253	115
123+384	421	7.5	4	6.7	250	113
127+251	400	7.4	1.8	7.6	208	113
128+986	500	7.5	1.8	6.1	196	121
130+988	450	7.6	1.6	8.1	300	115
143+165	250	7.4	2	5.8	107	113

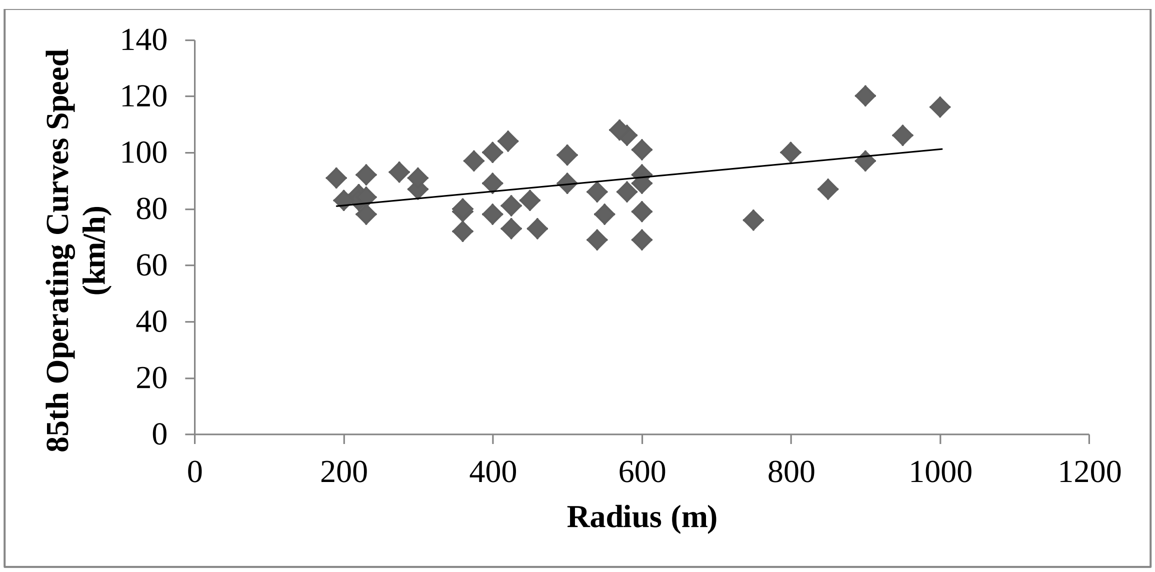

Figure 4.1 85th percentile horizontal curve speed versus radius.

In figure 4.1 the relationship between the 85th percentile operating speed and radius of curves results shows that as the radius increased, the 85th percentile operating speed of horizontal curve speeds increases.

Figure 4.2 85th percentile horizontal curve speed versus total pavement width

In figure 4.2 the relationship between the total pavement width and 85th percentile operating speed results show that Pavement width with 85th percentile operating speed did not show more relationships.

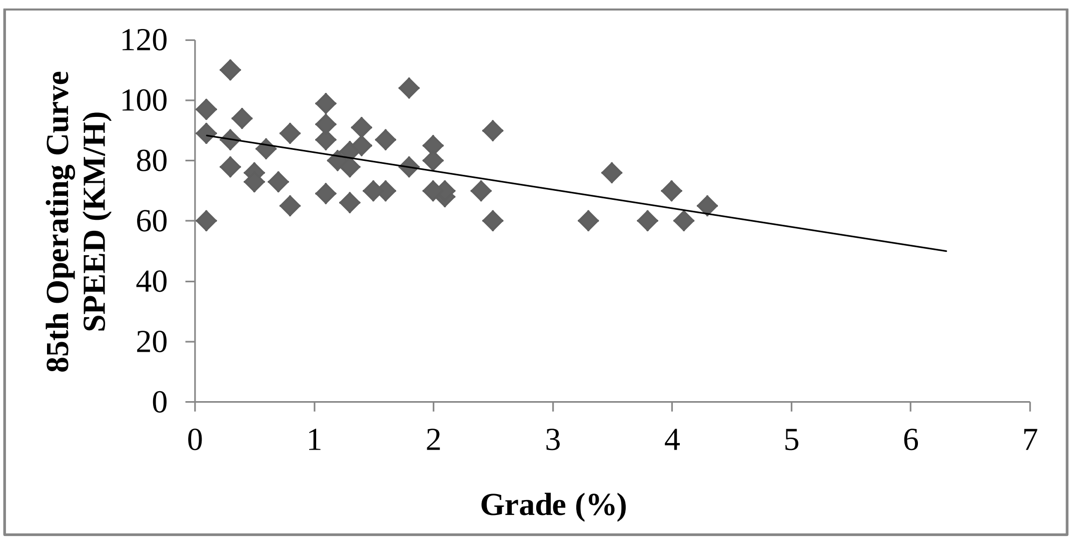

Figure 4.3 85th percentile horizontal curve speed versus grades.

In figure 4.3 the relation between the 85th operating speed and grade results show that as grade increased, the 85th percentile operating speed horizontal curve speeds decrease.

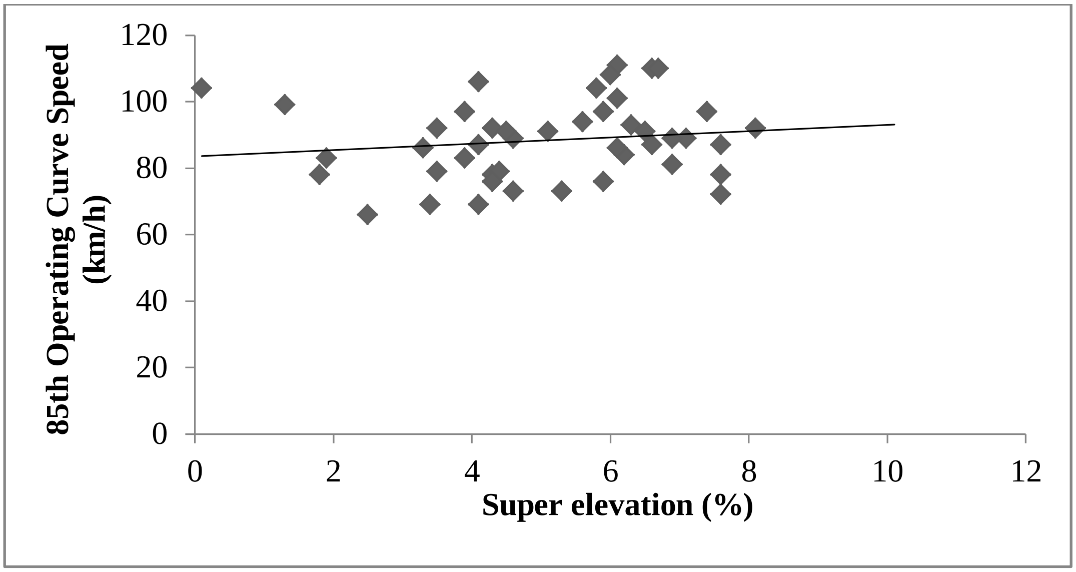

Figure 4.4 85th percentile horizontal curve speed versus super elevations.

In figure 4.4 the relationship between the 85th operating speed and super elevation results show that as super elevation increased, the 85th percentile operating speed of horizontal curve speed increase.

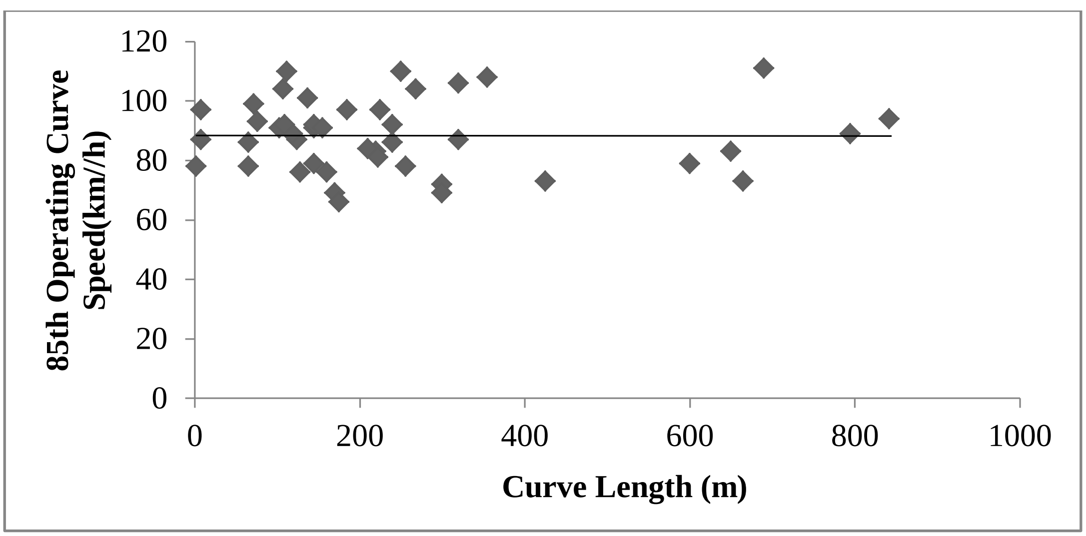

Figure 4.5 85th percentile horizontal curve speed versus curve length

In figure 4.5 the relationship between the curve length and operating speed result shows that as the curve length increased the 85th percentile operating speed of horizontal curves speeds increases proportionality.

Table 4.12 Geometric elements and 85th operating speed on tangents sections.

Station(km)	Tangent(m)	Total pavement Width (m)	Grade (%)	85th Speed on Tangent (km/h)
2+871	1000	7.2	1	126
5+927	1650	7.3	2.9	127
9+178	332	7.5	3.8	123
10+627	250	7.12	2.5	125
13+900	540	7.5	2.5	126
16+903	3365	7.2	0.1	126
19+375	2860	7.4	0.1	122
23+830	650	7.5	2.5	126
26+474	700	7.3	0.6	126
28+669	800	7.3	0.9	126
31+739	700	7.2	0.9	125
34+446	1460	7.2	1.3	127
37+285	890	7.2	1.5	127
39+270	1060	7.2.	1.3	127
41+407	1765	7.3	0.5	124
43+956	2500	7.16	1.1	125
45+724	2360	7.4	0.4	125
49+176	1220	7.5	0.3	125
54+171	780	7.12	3.8	126
56+621	565	7.12	0.7	126
57+918	2180	7.2	0.6	127
59+433	300	7.3	0.6	127
66+471	530	7.4	1.1	127
73+173	1440	7.2	0.3	129
83+459	523	7.3	0.3	129
121+107	1650	7.12	0.3	129
3+818	3590	7.1	0.1	127
6+405	456	7.2	2.9	128
11+054	3821	7.1	0.3	128
13+436	431	7.2	2.3	127
20+657	574	7.3	1.3	127
31+906	635	7.4	2.4	127
38+152	736	7.5	0.9	126
41+899	572	7.3	2.3	127
52+956	537	7.4	2.1	127
62+331	491	7.5	2.5	126
81+734	533	7.4	1.7	125
83+462	500	7.2	3.5	126
102+820	262	7.3	1.5	126

123+634	545	7.4	1.6	126
123+877	297	7.5	2.3	127
128+131	267	7.4	3.8	126
129+455	545	7.3	1.8	127
131+479	297	7.2	1.6	127
143+777	238	7.2	1.9	126

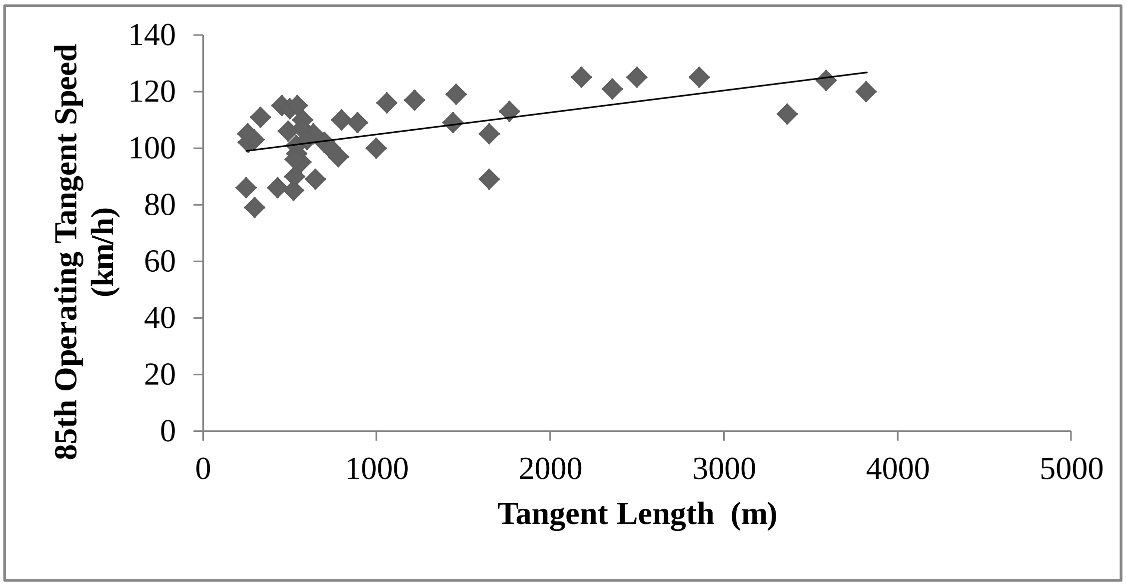

Figure 4.6 85th percentile tangent speeds versus tangent lengths.

In figure 4.6 the relationship between the tangent length and 85th percentile operating speed on tangents section result shows that as the tangent length increased and the 85th percentile operating speed of tangent speeds increases proportionality.

Figure 4.7 85th percentile tangent speeds versus total pavement widths.

In figure 4.7 the relationship between the total pavement width and 85th percentile operating speed results show that Pavement on tangent section width with 85th percentile operating speed did not show more relationships.

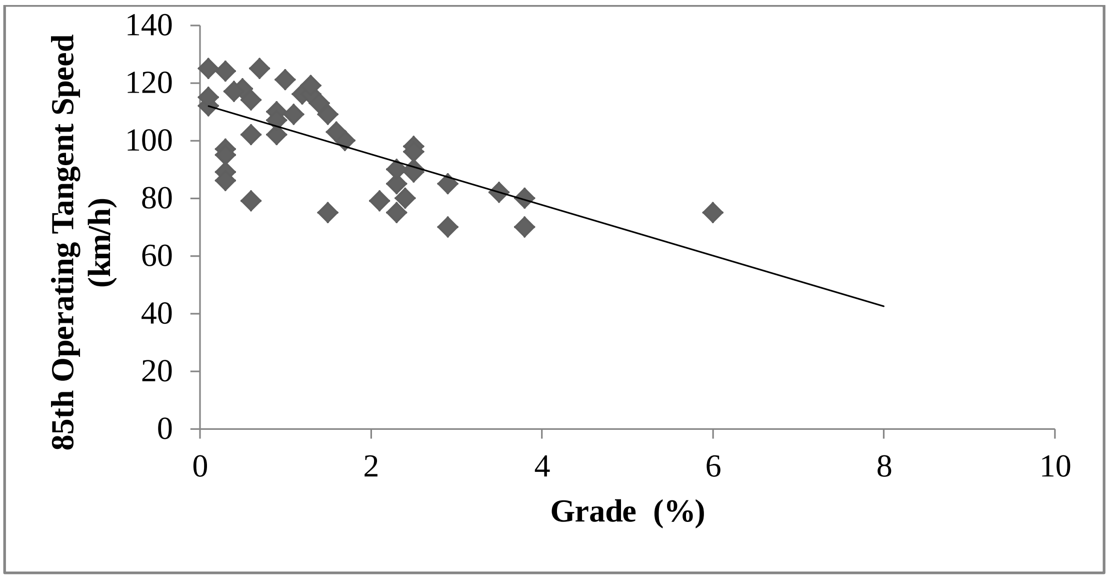

Figure 4.8 85th percentile tangent speeds versus grades

In figure 4.8 the relation between the 85th operating speed and grade results show that as grade increased, the 85th percentile operating speed of tangent speeds decrease.

4.2 Development of operating speed prediction model

The methodology used in this study is based on the development 85th operating speed prediction models incorporating design consistency measures. The linear regression modeling approach is adopted for model development. Relationship between road safety and the one category of geometric design consistency measures: Operating speed. The measures selected to represent each the 85th operating speed and the corresponding model used are presented below.

4.2.1 Correlation Analysis between Variables

To determine whether there was a relationship between the 85th percentile speed for horizontal curve and tangent with the geometric elements shown in the table 4.9, a correlation analysis were made between 85^{th} percentile operating speed and geometric elements, and between geometric elements. The results of the correlation are listed in table 4.9 and table 4.10.

Table 4.13 Correlation results of horizontal curves.

	85th	Grade	Super elevation	Curve Length	Pavement Width
Radius	0.188	-0.058	-0.39	-0.104	0.229
Total Pavement Width	-0.28	0.053	-0.365	0.011	1
Grade	-0.543	1	0.169	-0.268	0.053
Super elevation	-0.390	0.169	1	-0.167	-0.365
Curve Length	0.421	-0.268	-0.167	1	0.011

Table 4.14 Correlation results of tangents

	85th	Grade	Tangent Length
Total Pavement Width	-0.237	0.092	-0.015
Grade	-0.284	1	-0.299
Tangent Length	0.228	-0.299	1

From the correlation result in the table 4.13 and 4.14, grades super elevation and curve length was correlated with the operating speed on the horizontal curves whereas, grade and tangent le ngth were correlated on tangents. Hence the correlated geometric elements have an effect on t he 85^{th} percentile of horizontal curve and tangent section.

4.2.2 Regression Analysis

In order to identify the most promising combination of independent variable, a linear regression on procedure was used. The linear regression selection procedure possible combination of variable presented. The models were tested for statistical significant. The process of the test is check whether any of the regression parameters (β_i) were not significant difference from zero and whether their contribution or not significant to the estimation of speed. To determine whether there was a statistically relation for 95% percent confidence interval (significant level of a =1.96) a regression analysis were made between the geometric elements and operating speeds. The analysis was made in two ways, first between the geometric elements and operating speed and second between the combination of geometric elements and operating speeds. The results of the regression analysis are listed in table 4.15 and 4.16.

Table 4.15 Regression analysis results for simple and multiple linear equations for 85^{th} percentile speed of horizontal curves.

		G	S	CL	R2	MSE	βo
1	β1	-7.9			0.41	3618.95	133.89
	p-value	0.001					
2	β1		-3.79		0.35	1932.34	141.11
	p-value		0.012				
3	β1			0.103	0.063	808.62	135.12
	p-value			0.021			
4	β1	-7.162	-2.990		0.570	2361.91	147.87
	p-value	0.001	0.024				
5	β1		-3.46	0.022	0.179	1141.92	135.11
	p-value		0.024	0.196			
6	β1	-7.433		0.010	0.296	1892.09	130.51
	p-value	0.001		0.396			
7	β1	-6.881	-2.885	0.007	0.376	1597.83	145.19
	p-value	0.001	0.032	0.562			
	p-value	0..002	0.036				
Where: G= Grade S= super elevation CL = Curve Length R2 = Coefficient of determination MSE = Mean square Error βo = x constant P-value= Probability value							

Analysis of regression result indicate s that, grade, super elevation and the combination of grade and super elevation was found to be a significant predictor of 85th percentile speed on curves. Whereas curve length, radius and pavement width were not a significant predictor of desired speed of motorists on curves of two lane rural highway roads.

Table 4.16 Regression analysis results for simple and multiple – linear equation for 85th percentile speed on tangents.

		G	TL	R2	MSE	βo
1	β1	-4.461		**0.591**	2387.88	127.3
	p-value	0.001				
2	β1		0.005	0.321	976.33	114.21
	p-value		0.031			
3	β1	-3.955	0.325	0.523	1333.53	123.52
	p-value	0.0023	0.013			
Where: G= Grade TL = Tangent Length R2 = Correlation Coefficient of determination MSE = Mean Square Error βo = Constant P- value = Probability value						

Analysis of regression for tangent section indicates that, grade and tangent length was found to be a significant predictor of 85th percentile speed on tangents. Whereas pavement width was not a significant predictor of desired speed of motorists on tangents of two lane rural highway roads.

4.2.3 Regression Equation for 85th Percentile Speed on Horizontal Curves and Tangents

From the analysis results three of these models for horizontal curves that used combination of the three variables were determined to be a significant estimator of 85th percentile speeds in horizontal curves. Whereas two for tangents that used combination of two variables were determined to be a significant estimator of the 85th percentile in tangents. From the regression results a value with high value of R^2 was selected to show the regression equation for the collected data's in the field. The coefficient of determination shows that the combination of grade and super elevation with 57% and the coefficient of determination for grade is 41% of the values were speed prediction in curves, Whereas, coefficient of determination for the combination of grade and tangent length with 52.3% was speed predictors in tangent sections, and the coefficient of determination for the grade is 59.1%.Hence, the regression equation with coefficient of determination with high value for curves and tangent section are stated below:

For horizontal curves

Using simple linear regression equation

V85= 133.89 -7.9G……….…………………………… …… (Equation, 4.1) $R^2 = 0.41$.

Using multiple linear regression equation

V85= 124.88 -7.162G-2.990S…………………………………. (Equation, 4.2) $R^2 = 0.57$.

Where:

V85 = 85th percentile operating speed of horizontal curves (km/h), G = Grade (%);
S = Super elevation (m), and R^2 = Correlation Coefficient of Determination.

For Tangents

Using simple linear regression equation

V_{85}^{th} = 127.3-4.461G……………………………….. …… (Equation, 4.3) $R^2 = 0.591$.

Using multiple linear regression equation

V_{85}^{th}=123.52 + 0. 321 TL-0.3995G……………………..… (Equation, 4.4) R^2 = 0.523.

Where:

V85 = 85^{th} percentile operating speed of tangents, G=Grade (%); TL = Tangent Length (km))

R^2 = Correlation Coefficient of Determination.

4.2.4 Relationship between Observed Speed and Predicted Speed

The geometric for shashemene–Wolayta Sodo road collected data used as part of this study was use to show a relationship between observed speeds and predicted speed. The road was chosen because it had several tangents along with several horizontal curves. The road 130km in length, the horizontal curves length ranged from 107 to 795m in length and the tangent length ranged from 238m to 3500m in length. This resulted in the prediction of speed on horizontal curves and tangents. Table 4.17 and Table 4.18 shows that results obtained for operating speeds using the regression developed for curves and tangent sections. Figure 4.9 and Figure 4.10 shows the relationship between observed speed and predicted speed for curves and tangents.

Table 4.17 Results of operating speed using the regression equations developed for curves.

Road	stations	Grade (%)	Super elevation (%)	V_{85} = 147.88-7.162 G-2.99S Speed km/hr	V_{85}th on curve km/hr
Shashemene to Wolayta Sodo	2+249	3.3	3.3	114.9	86
	4+757	1.6	6.1	118.1	111
	8+878	2	0.1	133.2	104
	10+382	2.1	4.3	120.1	92
	13+558	2.5	5.1	114.6	91
	15+108	0.1	3.5	136.5	79
	17+795	0.1	3.9	135.4	97
	22+828	2.5	7.6	107.3	72
	26+064	0.8	4.6	128.8	89
	28+209	1.1	4.1	127.7	69
	31+279	1.3	3.9	127.4	83
	33+886	1.2	4.1	127	106
	36+863	1.1	4.1	127.6	87
	37+723	1.1	3.5	129.4	92
	40+834	1.1	2.5	131.1	66
	43+126	1.3	4.3	133.1	78
	44+664	0.3	4.4	124	79

	47+594	0.7	5.12	128.2	108
	52+841	0.8	4.6	129.5	73
	55+431	0.5	3.4	132.2	69
	57+428	0.6	4.3	131.4	76
	58+729	0.4	6.2	125.1	84
	65+056	2.1	5.6	128.6	94
	72+912	2.4	2.5	126.9	83
	82+982	2.2	1.8	127.5	81

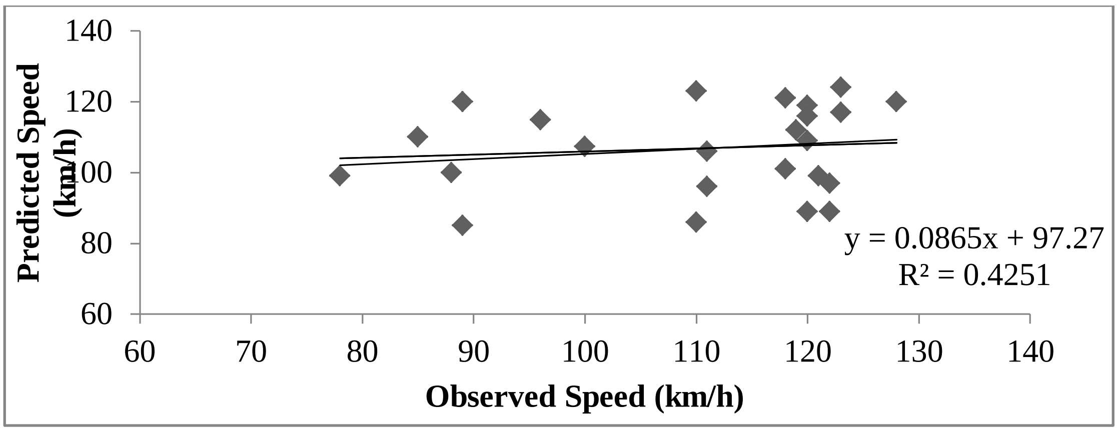

Figure 4.9 Observed speed versus predicted speed on horizontal curves.

Table 4.18 Results of operating speeds using the regression equation developed for Tangents.

Road	stations	Grade (%)	Tangent Length(m)	V85 = 123.53+0.321TL-0.399G Speed km/hr	V85th on Tangent km/hr
Shashemene to Wolayta Sodo	2+871	1.1	1000	122.8	116
	5+927	2.9	1650	114.5	109
	9+178	3.8	332	110.6	111
	10+627	2.5	250	116.1	102
	13+900	2.5	540	116.1	98
	16+903	0.1	3365	127	112
	19+375	0.1	2860	127	96
	23+830	1.8	1210	119.5	89
	26+474	2.5	650	116.1	102
	28+669	0.6	700	125	110
	31+739	0.9	600	123	102
	34+446	0.9	800	123	89
	37+285	0.9	700	121.5	109
	39+270	1.3	1460	120.2	116
	41+407	1.5	890	121.6	113

	43+956	1.3	1060	121.7	112
	45+724	1.4	1756	125.3	121
	49+176	0.5	2500	123	117
	54+171	1	2360	126.1	97
	56+621	0.4	1220	126	95
	57+918	0.3	780	110.6	108
	59+433	3.8	565	124.4	79
	66+471	0.7	2180	124.8	114
	73+173	0.6	300	126.9	109
	83+459	0.5	530	127.2	95

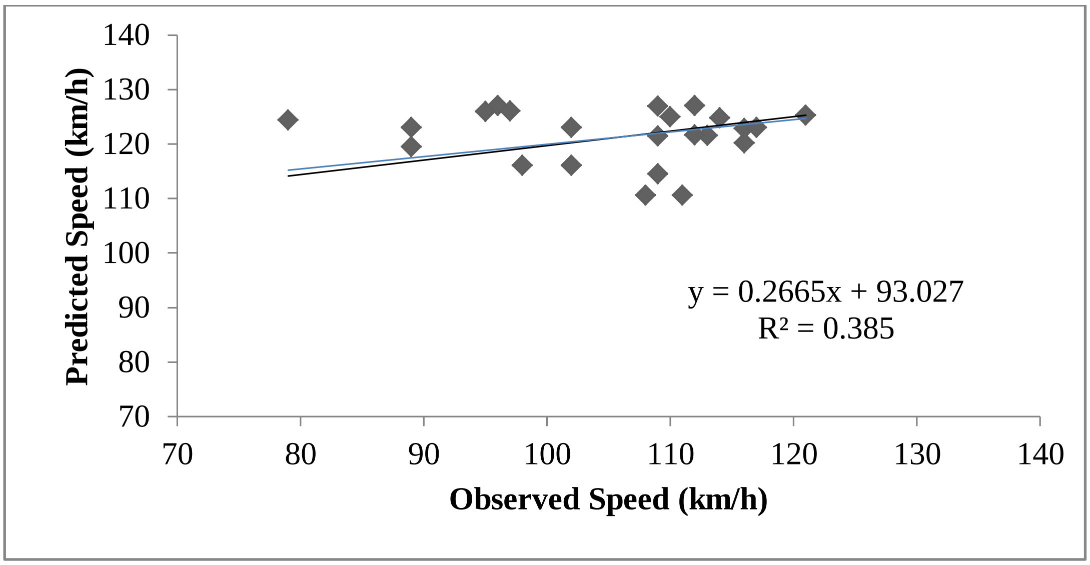

Figure 4.10 Observed speeds versus predicted on tangents

From the whole discussion it was hypothesized that motorists select the speed they drive based on previous alignment characteristics they have encountered. Since alignment indices quantify the general character of the road alignment, they were used in this research to represent the geometry motorists' encounter on tangents and horizontal curves. Using this principle, the objective of this analysis was to evaluate the applicability of using geometric elements in estimating the desired speed of motorists on tangents and horizontal curve of two-lane rural highways.Geometric elements were identified and developed. In order to compute and evaluate the indices, spot speed and aliment data were collected from sites located in two roads across south Ethiopia. After the alignment data were collected and entered into a computerized format, the geometric elements were calculated.

These geometric elements were then compared to observed 85th percentile speed on tangents and horizontal curves. Graphical and analyses were performed to determine if the geometric elements were significant prediction of the desired speed of motorists on tangents and horizontal curves of two-lane rural highways. The results specify that combination of geometric elements and other geometric variables were able to predict the 85th percentile speed motorists on tangents and horizontal curve of two-lane rural highways. Grade and super elevation was predictor of the 85th percentile curve speeds on two-lane rural highways. Whereas grade and on the tangent section was the predictor of the 85th percentile tangent speed on two-lane rural highways.

5. CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

Geometric design consistency is the conformance of geometry of a highway with driver expectancy. Despite it's important to road safety. Geometric design consistency is not ensured in a current design practice of ERA manual. The inadequacy of the design speed concept, the fact that the design speed may not be the maximum permissible safe speed, and progressive change to geometric design standard, which result in section along the same highway with inconsistent is one of the source of design inconsistency.

The following conclusion were developed based on the finding of the study

- Results of design consistency evaluation of operating speed between simple circular cure and tangent section shows that thirteen sections were under good design condition, twelve sections were under fair design and twenty sections were under poor design. Hence, from the evaluation result 71% of the section show design inconsistency.
- The result design consistency evaluation of operating speed and design speed for horizontal curve shows that twenty sections were under good design, sixteen sections were under fair and nine sections were under poor design and in tangent section four sections were good design, ten sections were under fair design and thirty one were under poor design. This result shows inconsistency and the operating speed observed was greater than 20km/h from the design speed. Hence consideration should be made by the Ethiopian Road Authority to incorporate this in design procedure in order to reduce accidents and/or that may occur due to this inconsistency.
- Finding from design consistency evaluation based on vehicle stability indicated that the change in design side friction and demanded side friction four sections were greater than 0.01 which was under good design condition and fourteen sections were less than 0.01 and greater than -0.04 which was under fair design condition. The corresponding result for the rest of the twenty seven section were less than -0.04 which was under poor design performance. They need realignment during maintenance. Hence, most of the section showed design inconsistency from the evaluation.

- This study has produced significant relationships that can be used to calculate the expected speed at tangents and horizontal curves which can be improved by future research study.
- Grade and super elevation were significant variable in the regression equation developed for the operating speed of motorists on horizontal curves of two-lane rural highways and grade and tangent were found as a variable in the regression equation for the operating speed of motorists on tangent section of two-lane rural highways.
- From the regression model it was show that there was no more statistically significant difference between the 85^{th} percentiles observed speed and the predicted speed of horizontal curve and tangent sections.

5.2 Recommendations

The following recommendations were made based on the results of this study:

- Further research should be conducted to extend all aspects of this research, such as by collecting more data in order to improve results and also by including the effects of vertical curves.
- From the consistency evaluation result it shown that roads were more than 50% has design inconsistency. Hence, the Ethiopia Roads Authority consider the effect of consistency and needs further research and incorporate the consideration of design consistency in the design manual.
- The performance evaluation of the road sections based on operating speed showed that 71% percentile section were under fair design and poor design and 71% percentile drivers were operating speed of 20km/h more than the provided design speed. Therefore, it is better to provide speed breaker in entrances and exits of horizontal curves.
- Extend this research on speed prediction equation to include the effects of acceleration and deceleration behavior and the speed profile.
- The existing system should be modified to improve the accuracy, uniformity, and effectiveness of the available information upon which drivers select an appropriate speed and path through a tangent and horizontal curve section.

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APPENDIXES

Appendix A – Data Collection from Field

Appendix B – Data Analysis for the 85th Percentile Speed for tangent and curve section

Appendix C – Regression Analysis

APPENDIX A

A1. Data Collection from Field for curve section

Road Shashemene- Wolayta Sodo width of pave(m) = 7.5 Grade(%) = 3.3
Station 2+127 to 2+371 Shoulder width (m) = 2 Left Radius(m) = 540
Horizontal curve 2+249 = 2.4 Right super elevation(%) = 3.4
Date :DD/MM/YY End Time: ... Start Time...
Location:-near Shashemene Downtime: N,A
Weather :clear

Passenger cars			Buses			Truck		
Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)
2.95	11	99	2.59	9	113	3.3	7	89
3.12	6	94	2.92	11	100	3.4	8	87
2.65	12	110	2.61	13	112	3.58	7	81
3.25	9	90	3.32	12	89	3.57	8	82
2.62	9	112	2.97	4	98	3.64	10	80
2.78	10	105	2.64	3	110	3.74	9	78
2.91	4	100	2.96	10	99	3.39	7	86
2.34	7	125	3.13	3	93	3.45	4	83
2.54	11	115	3.31	6	88	3.81	12	76
2.69	10	108	3.18	8	92	3.32	6	88
2.75	4	106	2.79	9	105	3.69	10	79
2.59	7	113	2.87	12	102	3.71	12	78
Total	100		Total	100		Total	100	

Road Shashemene- Wolyta Sodo width of pave(m) = 7.5 Grade(%) = 1.6
Station 4+412 to 5+102 Shoulder width (m) = 1.5 Left Radius(m) = 360
Horizontal curve 4+757 = 2.1 Right super elevation(%) = 6.1
Date :DD/MM/YY End Time: Start Time:
Location: near Shsshemene Downtime: N,A
Speed Lime: Weather :clear

Passenger cars			Buses			Truck		
Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)
2.96	10	98	2.59	10	113	3.32	8	88
3.22	9	91	2.92	6	100	3.43	8	85
2.96	8	98	2.87	9	101	3.2	10	91
2.75	8	106	3.25	10	86	3.51	8	83
2.52	11	117	2.72	9	108	3.53	9	81
3.12	9	94	3.3	13	89	3.41	7	85
2.34	12	125	3.13	8	93	3.45	9	83
2.54	11	115	3.31	12	88	3.81	8	76
2.69	10	108	3.18	8	92	3.32	11	88
2.75	7	106	2.99	8	98	3.82	10	76

2.86	5	102	2.87	7	102	3.74	12	78
Total	100		Total	100		Total	100	

Road Shashemene- Wolyta Sodo width of pave(m) = 7.5 Grade(%) = 2.1
Station 8+744 to 9+012 Shoulder width (m) = 1.2 Left Radius(m) = 900
Horizontal curve 8+878 = 1.3 Right super elevation(%) =0.1
Date :DD/MM/YY End Time: Start Time:
Location: nearShashemen Downtime: N,A
Speed Lime: Weather :clear

Passenger cars			Buses			Truck		
Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)
2.94	10	99	3.15	9	93	3.29	10	89
3.21	9	92	2.96	11	98	3.46	11	85
3.25	11	90	3.32	7	89	3.57	9	82
2.68	9	108	2.97	10	98	3.64	9	80
2.78	10	105	2.64	13	110	3.74	10	78
2.91	9	100	2.96	10	99	3.39	8	86
2.34	12	125	3.13	8	93	3.45	10	83
2.53	11	115	3.31	12	88	3.81	12	76
2.69	10	108	3.18	8	92	3.32	11	88
2.71	9	109	2.84	12	103	3.37	10	87
Total	100		Total	100		Total	100	

Road Shashemene- Wolyta Sodo width of pave(m) = 7.5 Grade(%) = 2.1
Station 10+262 to 10+502 Shoulder width (m) = 2.3 Left Radius(m) = 600
Horizontal curve 10+382 = 1.5 Right super elevation(%) = 4.3
Date :DD/MM/YY End Time: Start Time:
Location: near Shashemene Downtime: N,A
Speed Lime: Weather :clear

Passenger cars			Buses			Truck		
Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)
2.91	8	100	2.62	6	110	3.39	8	86
2.79	9	105	2.92	10	100	3.45	7	83
2.96	8	98	2.87	9	101	3.28	10	89
2.75	8	106	3.25	5	86	3.51	8	83
2.52	10	117	2.72	9	108	3.53	7	81
3.12	9	94	3.32	8	88	3.41	8	85
2.78	7	105	3.10	11	95	3.43	12	84
3.18	11	92	2.95	12	99	3.61	10	81
2.54	8	115	3.31	7	88	3.81	9	76
2.69	8	108	3.18	8	92	3.37	8	84
2.75	9	106	2.92	8	100	3.82	8	76

2.91	5	99	2.69	7	108	3.37	5	87
Total	100		Total	100		Total	100	

Road Shashemene-Wolayta Sodo width of pave(m) = 7.5 Grade(%) = 2.5
Station 13+485 to 13+630 Shoulder width (m) = 2 Left Radius(m) = 360
Horizontal curve 13+558 = 2.4 Right super elevation(%) = 5.1
Date :DD/MM/YY End Time: Start Time:
Location: near Sheshsmene Downtime: N,A
Speed Lime: Weather :clear

Passenger cars			Buses			Truck		
Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)
2.89	8	101	2.79	14	105	3.39	11	87
2.95	6	99	2.97	11	99	3.4	12	78
2.94	5	100	2.84	9	100	3.2	10	67
3.18	12	110	2.92	12	110	3.40	11	79
3.01	10	110	2.76	12	109	3.39	8	83
2.53	13	104	2.87	8	104	2.98	12	78
2.65	8	115	2.61	8	115	3.58	6	94
3.25	7	90	3.32	5	117	3.57	9	84
2.68	9	108	2.97	4	118	3.40	4	88
2.94	10	100	2.64	10	121	3.74	10	83
2.96	12	89	2.96	7	89	3.39	7	89
Total	100		Total	100		Total	100	

Road Shashemene-Wolayta Sodo width of pave(m) = 7.5 Grade(%) = 0.2
Station 14+995 to 15+220 Shoulder width (m) = 1.7 Left Radius(m) = 400
Horizontal curve 15+108 = 1.9 Right super elevation(%) = 3.5
Date :DD/MM/YY End Time: Start Time:
Location: near Shashemene Downtime: N,A
Speed Lime: Weather :clear

Passenger cars			Buses			Truck		
Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)
2.98	14	101	2.59	7	102	3.37	12	87
3.12	10	97	2.42	11	103	3.45	11	84
3.23	9	96	2.93	9	100	3.57	10	79
2.98	10	101	3.25	10	96	3.51	8	96
2.55	11	110	2.72	10	107	3.53	9	87
3.12	9	105	3.87	8	105	3.41	12	92
2.78	11	112	3.10	12	112	3.43	11	90
2.96	11	82	2.96	10	82	3.39	7	82
3.69	10	78	3.13	8	78	3.45	9	78
3.25	4	89	3.31	15	99	3.85	10	89

Total	100		Total	100		Total	100	

Road Shashemene-Wolayta Sodo width of pave(m) = 7.5 Grade(%) = 0.13
Station 17+645 to 17+945 Shoulder width (m) = 1.6 Left Radius(m) = 600
Horizontal curve 17+795 = 2.1Right super elevation(%) = 3.9
Date :DD/MM/YY End Time: Start Time:
Location: near Shashemene Downtime: N,A
Speed Lime: Weather :clear

Passenger cars			Buses			Truck		
Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)
2.92	6	109	2.59	5	102	3.3	12	80
3.31	5	98	2.92	11	100	3.4	8	78
3.26	12	89	2.84	9	100	3.2	10	87
2.99	5	96	3.25	10	96	3.51	8	96
2.52	8	110	2.72	9	110	3.53	9	86
2.75	9	109	2.99	9	109	3.32	7	87
3.18	12	110	2.92	12	110	3.40	8	92
3.01	11	89	2.76	8	89	3.39	8	89
2.53	8	87	2.87	11	87	2.98	12	87
2.65	8	85	2.61	8	85	3.58	5	85
3.25	7	102	3.32	2	102	3.59	9	84
2.61	9	104	2.97	6	89	3.54	4	89
Total	100		Total	100		Total	100	

Road Shashemene-Wolayta Sodo width of pave(m) = 7.5 Grade(%) = 2.5
Station 22+430 to 23+225 Shoulder width (m) = 1.6 Left Radius(m) = 450
Horizontal curve 22+828 =1.9 Right super elevation(%) = 7.6
Date :DD/MM/YY End Time: Start Time:
Location: nearShashemne Downtime: N,A
Speed Lime: Weather :clear

Passenger cars			Buses			Truck		
Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)
2.92	12	109	2.59	10	102	3.3	13	80
3.31	10	98	2.92	11	100	3.4	8	78
3.26	7	89	2.84	9	100	3.2	10	87
2.99	10	96	3.25	10	96	3.51	8	96
2.52	8	110	2.72	9	110	3.53	9	86
3.12	8	105	3.3	13	105	3.41	7	89
2.78	12	112	3.10	12	112	3.43	11	79
3.26	7	89	2.84	9	100	3.2	10	87
2.99	10	96	3.25	5	96	3.51	8	96
2.52	8	110	2.72	4	110	3.53	9	86

3.12	13	105	3.3	8	105	3.41	7	89
Total	100		Total	100		Total	100	

Road Shashemene-Wolayta Sodo width of pave(m) = 7.5 Grade(%) = 0.8
Station 25+979 to 26+149 Shoulder width (m) = 1.8 Left Radius(m) = 540
Horizontal curve 26+064 = 1.4 Right super elevation(%) = 4.6
Date :DD/MM/YY End Time: Start Time:
Location: near Shashemene Downtime: N,A
Speed Lime: Weather :clear

Passenger cars			Buses			Truck		
Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)
2.89	11	106	3.23	12	89	3.39	12	84
2.69	10	112	2.92	11	100	3.47	12	81
2.96	9	109	3.56	9	83	3.59	10	80
3.01	8	89	2.76	8	89	3.39	8	89
2.53	10	87	2.87	8	87	2.98	12	87
2.65	8	85	2.61	13	85	3.58	7	85
3.25	11	102	3.32	7	102	3.57	13	80
2.68	9	85	2.97	9	85	3.64	9	85
2.78	8	84	2.64	8	84	3.74	10	84
2.96	6	82	2.96	15	82	3.72	7	78
Total	100		Total	100		Total	100	

Road Shashemene-Wolayta Sodo width of pave(m) = 7.5 Grade(%) = 1.1
Station 28+099 to 28+319 Shoulder width (m) =1.4 Left Radius(m) = 580
Horizontal curve 28+209 = 1.6 Right super elevation(%) = 4.1
Date :DD/MM/YY End Time: Start Time:
Location: near Alaba Downtime: N,A
Speed Lime: Weather :clear

Passenger cars			Buses			Truck		
Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)
2.89	11	106	3.23	14	89	3.39	9	84
2.69	12	112	2.92	12	100	3.47	13	81
2.96	11	109	3.56	11	83	3.59	13	80
2.99	12	96	3.25	10	96	3.51	12	96
2.52	12	110	2.72	9	110	3.53	11	85
3.12	7	105	3.3	11	105	3.62	11	82
2.78	12	112	3.10	12	112	3.43	13	95
3.18	11	107	2.95	11	107	3.61	10	79
3.92	12	104	3.00	10	104	3.56	8	87
Total	100		Total	100		Total	100	

Road Shashemene-Wolayta Sodo Station 31+119 to 31+439 Horizontal curve 31+279 Date :DD/MM/YY Location: near Alaba Speed Lime:			width of pave(m) = 7.5 Shoulder width (m) = 2.3 Left =1.9 Right End Time: Downtime: N,A Weather :clear			Grade(%) = 1.3 Radius(m) = 400 super elevation(%) =3.9 Start Time:		
Passenger cars			Buses			Truck		
Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)
2.89	10	106	3.23	11	89	3.39	8	84
2.69	10	112	2.92	9	100	3.47	10	81
2.96	12	109	3.56	8	83	3.59	14	80
2.99	9	96	3.25	11	96	3.51	12	96
2.75	5	109	2.99	9	109	3.32	9	81
3.18	12	110	2.92	12	110	3.78	7	77
3.01	11	89	2.76	10	89	3.39	10	89
2.53	9	87	2.87	11	87	2.98	11	87
2.65	9	85	2.61	10	85	3.58	10	85
3.25	13	102	3.32	9	102	3.57	9	80
Total	100		Total	100		Total	100	

Road Shashemene-Wolayta Sodo Station 33+726 to 34+046 Horizontal curve 33+886 Date :DD/MM/YY Location: near Alaba Speed Lime:			width of pave(m) = 7.5 Shoulder width (m) = 1.8 Left = 2.1 Right End Time: Downtime: N,A Weather :clear			Grade(%) = 1.2 Radius(m) = 900 super elevation(%) = 4.1 Start Time:		
Passenger cars			Buses			Truck		
Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)
2.96	10	114	2.59	12	97	3.65	5	79
3.16	6	109	2.92	9	89	3.46	9	94
3.34	9	100	2.84	8	86	3.27	6	96
3.51	12	96	3.25	5	96	3.51	9	96
2.52	3	110	2.72	10	110	3.53	8	85
3.12	11	105	3.3	8	105	3.41	7	84
2.78	9	112	3.10	14	102	3.43	6	96
3.18	12	107	2.95	6	107	3.61	12	78
2.75	9	108	2.72	12	118	3.45	11	79
3.18	9	101	3.3	9	101	3.81	13	81
3.01	10	94	3.10	7	89	3.32	14	89
Total	100		Total	100		Total	100	

Road Shashemene-Wolayta Sodo	width of pave(m) = 7.5	Grade(%) = 1.1

Station 36+790 to 36+935 Horizontal curve 36+863 Date :DD/MM/YY Location: near Asesa Speed Lime:			Shoulder width (m) = 1.4 Left = 1.7 Right End Time: Downtime: N,A Weather :clear			Radius(m) = 550 super elevation(%) = 4.3 Start Time:		
Passenger cars			Buses			Truck		
Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)
2.36	8	114	2.59	9	97	3.65	10	79
3.16	6	109	2.92	5	89	3.46	4	94
3.34	3	100	2.84	3	86	3.27	3	96
3.51	5	96	3.25	5	96	3.51	5	96
2.52	12	110	2.72	10	110	3.53	12	85
3.12	8	105	3.3	9	105	3.41	8	84
2.78	7	112	3.10	7	102	3.43	9	96
3.18	10	107	2.95	10	107	3.61	8	78
2.78	5	103	2.64	6	103	3.56	5	94
2.96	6	112	2.96	6	102	3.64	6	78
2.69	14	103	3.13	13	103	3.32	14	79
2.96	7	104	3.31	8	104	3.40	7	89
2.99	9	111	3.18	9	101	3.39	9	96
Total	100		Total	100		Total	100	

Road Shashemene-Wolayta Sodo Station 37+635 to 37+810 Horizontal curve 37+723 Date :DD/MM/YY Location: near Asesa Speed Lime:			width of pave(m) = 7.5 Shoulder width (m) = 2 Left = 2.4 Right End Time: Downtime: N,A Weather :clear			Grade(%) = 1.1 Radius(m) = 600 super elevation(%) = 3.5 Start Time:		
Passenger cars			Buses			Truck		
Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)
2.87	10	102	2.58	10	102	3.37	12	82
2.69	12	106	2.92	12	89	3.46	10	93
2.96	7	100	2.84	7	94	3.24	7	79
2.99	10	96	3.25	10	96	3.51	10	96
2.52	13	110	2.32	13	110	3.53	13	107
3.12	9	96	3.3	9	96	3.41	9	96
2.99	8	117	3.18	8	89	3.32	8	97
2.52	12	121	2.79	12	118	3.69	12	104
2.26	9	116	2.87	9	78	3.71	9	87
2.98	10	89	2.59	10	89	3.3	10	89
Total	100		Total	100		Total	100	

Road Shashemene-Wolayta Sodo width of pave(m) = 7.5 Grade(%) = 1.3 Station 40+706 to 40+962 Shoulder width (m) = 1.6Left Radius(m) = 570
Horizontal curve 40+834 = 2..3Right super elevation(%) = 2.5
Date :DD/MM/YY End Time: Start Time:
Location: near Asesa Downtime: N,A
Speed Lime: Weather :clear

Passenger cars			Buses			Truck		
Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)
2.87	6	102	2.58	10	102	3.39	8	82
2.69	10	108	2.92	6	89	3.56	8	93
2.96	9	100	2.84	9	94	3.24	9	79
3.14	10	96	3.25	10	96	3.51	10	96
2.52	8	110	2.32	8	110	3.53	8	107
3.12	12	96	3.3	12	96	3.41	12	96
2.68	9	110	2.97	9	110	3.64	9	79
2.78	8	86	2.64	8	86	3.74	8	86
2.96	6	87	2.86	6	87	3.39	6	87
2.69	7	89	3.13	7	89	3.45	7	89
2.96	4	115	3.01	4	115	3.81	4	88
2.99	6	117	3.18	6	89	3.32	6	97
2.52	9	121	2.79	9	118	3.29	9	104
2.26	6	116	2.87	6	78	3.71	6	87
Total	100		Total	100		Total	100	

Road Shashemene-Wolayta Sodo width of pave(m) = 7.5 Grade(%) = 0. 3
Station 42+826 to 43+426 Shoulder width (m) = 1.9 Left Radius(m) = 460
Horizontal curve 43+126 = 2.1Right super elevation(%) = 4.3
Date :DD/MM/YY End Time: Start Time:
Location: near Asesa Downtime: N,A
Speed Lime: Weather :clear

Passenger cars			Buses			Truck		
Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)
2.77	12	105	2.98	11	102	3.39	12	82
2.89	10	101	3.42	11	89	3.56	10	93
2.96	9	99	2.84	9	94	3.24	9	79
3.14	9	96	3.25	10	96	3.51	10	96
2.52	9	110	2.32	8	110	3.53	8	84
3.14	10	96	3.25	10	96	3.51	10	96
2.52	8	110	2.32	8	110	3.53	8	87
3.12	10	96	3.34	10	96	3.41	10	96
2.78	7	97	3.10	7	97	3.43	7	97
3.18	6	85	3.95	6	85	3.61	8	85
3.92	10	100	3.00	10	100	3.56	8	97

Total	100		Total	100		Total	100	

Road Shashemene-Wolayta Sodo width of pave(m) = 7.5 Grade(%) = 1.5
Station 44+486 to 44+841 Shoulder width (m) = 1.8 Left Radius(m) = 1000
Horizontal curve 44+664 = 2.4 Right super elevation(%) = 4.4
Date :DD/MM/YY End Time: Start Time:
Location: near Asesa Downtime: N,A
Speed Lime: Weather :clear

Passenger cars			Buses			Truck		
Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)
2.65	6	110	2.98	6	102	3.39	6	86
2.89	5	101	3.42	5	89	3.56	5	82
3.12	10	96	3.3	10	96	3.41	10	96
2.78	9	97	3.10	9	97	3.43	9	97
3.18	6	85	2.95	6	95	3.61	6	85
3.92	10	100	2.99	10	100	3.56	10	97
3.01	9	98	2.76	9	97	3.39	9	93
2.26	5	116	2.87	5	78	3.71	5	87
2.87	9	102	2.58	9	102	3.39	9	82
2.69	8	108	2.92	8	89	3.56	8	93
2.96	12	100	2.84	12	94	3.24	12	79
3.14	11	96	3.25	11	96	3.51	11	96
Total	100		Total	100		Total	100	

Road Shashemene-Wolayta Sodo width of pave(m) = 7.5 Grade(%) = 0.3
Station 47+261 to 47+926 Shoulder width (m) = 1.4 Left Radius(m) = 360
Horizontal curve 47+594 = 1.9 Right super elevation(%) = 6.1
Date :DD/MM/YY End Time: Start Time:
Location: near Asesa Downtime: N,A
Speed Lime: Weather :clear

Passenger cars			Buses			Truck		
Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)
2.69	5	104	2.98	5	102	3.39	5	86
2.99	7	100	3.42	7	89	3.56	7	82
3.14	9	99	2.84	9	94	3.24	9	79
3.14	7	96	3.25	7	96	3.51	7	96
2.52	5	109	2.35	5	119	3.53	5	84
3.12	9	96	3.3	9	96	3.41	9	86
2.96	8	100	2.84	8	94	3.24	8	79
3.14	5	96	3.25	5	96	3.51	5	96
2.52	9	110	2.39	9	120	3.53	9	87
3.12	8	96	3.34	8	96	3.41	8	96

2.78	9	97	3.10	9	97	3.43	9	97
3.18	6	85	3.95	6	85	3.61	6	85
3.92	7	100	3.00	7	99	3.56	7	97
2.77	6	105	2.98	6	102	3.39	6	82
Total	100		Total	100		Total	100	

Road Shashemene-Wolayta Sodo width of pave(m) = 7.5 Grade(%) = 0.7
Station 52+691 to 52+991 Shoulder width (m) =1.4Left Radius(m) = 220
Horizontal curve 52+841 = 2.4 Right super elevation(%) = 4.6
Date :DD/MM/YY End Time: Start Time:
Location: near Boditi Downtime: N,A
Speed Lime: Weather :clear

Passenger cars			Buses			Truck		
Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)
2.79	4	105	2.98	4	102	3.79	4	77
2.99	8	100	3.42	8	89	3.56	8	82
3.14	7	99	3.84	7	76	3.24	7	79
3.14	5	99	3.25	5	96	3.51	5	96
2.52	7	109	2.35	7	119	3.53	7	84
3.12	9	96	3.3	9	96	3.41	9	86
3.14	11	96	3.25	11	96	3.51	11	96
2.52	6	110	2.39	6	120	3.53	6	87
3.12	8	96	3.34	8	96	3.41	8	96
2.78	6	97	3.10	6	97	3.43	6	97
3.18	6	85	3.95	6	85	3.61	6	85
3.92	9	75	3.00	9	99	3.56	9	97
2.77	6	105	2.98	6	102	3.39	6	86
2.69	8	104	2.93	8	100	3.39	8	86
Total	100		Total	100		Total	100	

Road Shashemene-Wolayta Sodo width of pave(m) = 7.5 Grade(%) = 0.8
Station 55+351to 55+511 Shoulder width (m) = 1.7 Left Radius(m) = 220
Horizontal curve 55+431 = 2.3 Right super elevation(%) =3.4
Date :DD/MM/YY End Time: Start Time:
Location: near Boditi Downtime: N,A
Speed Lime: Weather :clear

Passenger cars			Buses			Truck		
Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)
2.89	7	101	2.98	7	99	3.22	8	93
2.99	8	100	3.42	6	89	3.56	8	82
3.14	4	93	3.24	6	107	3.24	4	89

3.56	5	90	3.25	5	96	3.51	5	96
2.52	7	116	2.35	7	119	3.53	8	84
3.12	5	94	3.3	5	96	3.41	5	86
2.78	6	107	3.10	6	97	3.43	6	97
2.87	8	102	2.58	8	102	3.39	8	82
2.59	5	108	2.92	5	89	3.56	5	93
2.96	7	100	2.84	7	94	2.98	7	103
3.14	10	96	3.25	10	96	3.51	10	96
2.52	3	110	2.39	3	120	3.53	3	87
3.12	5	96	3.34	5	96	3.41	5	96
2.78	10	97	3.16	10	92	3.13	10	98
Total	100		Total	100		Total	100	

Road Shashemene-Wolayta Sodo width of pave(m) = 7.5 Grade(%) = 0.5
Station 57+318 to 57+528 Shoulder width (m) = 2 Left Radius(m) = 425
Horizontal curve 57+428 = 2.4 Right super elevation(%) = 4.3
Date :DD/MM/YY End Time: Start Time:
Location: near Asesa Downtime: N,A
Speed Lime: Weather :clear

Passenger cars			Buses			Truck		
Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)
2.79	3	105	2.98	3	99	3.89	3	75
2.99	8	100	3.32	8	89	3.56	8	82
3.12	13	96	3.34	13	96	3.41	13	96
2.78	10	97	3.16	10	92	3.13	10	98
2.89	13	101	2.98	13	99	3.22	13	93
2.99	13	100	3.42	13	89	3.56	13	82
3.14	9	93	3.24	9	107	3.24	9	89
3.56	10	90	3.25	10	96	3.51	10	96
2.52	9	116	2.35	9	119	3.53	9	84
3.12	12	94	3.3	12	96	3.86	12	76
Total	100		Total	100		Total	100	

Road Shashemene-Wolayta Sodo width of pave(m) = 7.5 Grade(%) = 0.6
Station 58+308 to 59+150 Shoulder width (m) = 2 Left Radius(m) = 452
Horizontal curve 58+729 = 2.4 Right super elevation(%) = 6.2
Date :DD/MM/YY End Time: Start Time:
Location: near Boditi Downtime: N,A
Speed Lime: Weather :clear

Passenger cars			Buses			Truck		
Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)

2.79	9	105	2.98	9	99	3.89	9	97
2.99	11	100	3.32	11	89	3.56	11	82
3.14	13	90	3.19	13	107	3.21	13	100
2.79	10	105	2.98	10	99	3.89	10	75
2.99	11	95	3.32	11	89	3.56	11	82
3.14	10	90	3.19	10	107	3.24	10	89
3.56	9	90	3.25	9	96	3.51	9	96
2.52	8	116	2.35	8	119	3.53	8	84
3.12	9	94	3.3	9	96	3.41	9	86
2.78	10	107	3.10	10	94	3.63	10	95
Total	100		Total	100		Total	100	

Road Shashemene-Wolayta Sodo width of pave(m) = 7.5 Grade(%) = 0.4
Station 64+731 to 65+381 Shoulder width (m) = 2 Left Radius(m) = 300
Horizontal curve 65+056 = 2.4 Right super elevation(%) = 5.6
Date :DD/MM/YY End Time: Start Time:
Location: near Boditi Downtime: N,A
Speed Lime: Weather :clear

Passenger cars			Buses			Truck		
Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)
2.79	12	105	2.98	12	99	3.89	12	97
2.99	9	100	3.32	9	89	3.56	9	82
3.14	8	90	3.19	8	107	3.21	8	100
3.56	10	90	2.85	10	107	3.51	10	96
2.52	7	116	2.35	7	119	3.53	7	84
3.12	6	94	3.3	6	96	3.86	6	76
2.79	2	105	2.98	2	99	3.89	2	75
2.99	6	100	3.32	6	89	3.56	6	82
3.14	9	90	3.19	9	107	3.24	9	89
3.56	5	90	3.25	5	96	3.51	5	96
2.52	7	116	2.35	7	119	3.53	7	84
3.12	10	94	3.3	10	96	3.41	10	86
2.78	9	107	3.10	9	94	3.63	9	95
Total	100		Total	100		Total	100	

Road Shashemene-Wolayta Sodo width of pave(m) = 7.5 Grade(%) = 2.1
Station 72+801 to 73+023 Shoulder width (m) = 2 Left Radius(m) = 500
Horizontal curve 72+912 = 2.4 Right super elevation(%) = 3.25
Date :DD/MM/YY End Time: Start Time:
Location: near Boditi Downtime: N,A
Speed Lime: Weather :clear

Passenger cars			Buses			Truck		
Record	Frequency	Speed	Record	Frequency	Speed	Record	Frequency	Speed

(sec)		(kph)	(sec)		(kph)	(sec)		(kph)
2.79	7	105	2.98	5	99	3.89	8	97
2.99	4	100	3.32	6	89	3.56	3	82
3.14	10	90	3.19	10	107	3.21	10	100
3.56	5	90	2.85	4	107	3.51	5	96
2.52	7	116	2.35	8	119	3.53	7	84
3.12	5	90	3.3	5	96	3.41	5	96
3.12	8	96	3.34	8	96	3.41	8	96
2.78	6	97	3.16	6	92	3.13	6	98
2.89	2	101	2.98	2	99	3.22	4	93
2.99	3	100	3.42	3	89	3.56	2	82
3.14	4	93	3.24	4	107	3.24	4	89
3.56	9	90	3.25	9	96	3.51	8	96
2.52	5	116	2.35	6	119	3.53	5	84
3.12	5	94	3.3	5	96	3.86	5	76
2.79	7	105	2.98	7	99	3.89	7	75
2.99	6	100	3.32	6	89	3.56	6	82
3.14	10	90	3.19	9	107	3.24	10	89
Total	100		Total	100		Total	100	

Road Shashemene-Wolayta Sodo   width of pave(m) = 7.5   Grade(%) = 0.1
Station 82+769 to 83+194   Shoulder width (m) = 2 Left   Radius(m) = 200
Horizontal curve 82+982   = 2.4 Right   super elevation(%) = 1.9
Date :DD/MM/YY   End Time: Start Time:
Location: near Welayta-Sodo   Downtime: N,A
Speed Lime: Weather :clear

Passenger cars			Buses			Truck		
Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)
2.79	10	105	2.68	3	109	3.89	3	97
2.99	13	100	3.32	4	89	3.56	3	82
3.14	9	90	3.19	2	106	3.61	2	81
3.56	10	90	2.85	5	107	3.51	5	96
3.25	13	90	3.25	6	96	3.51	8	96
2.52	12	116	2.35	7	119	3.53	6	84
2.93	14	118	3.42	3	89	3.56	3	82
3.14	10	93	3.24	4	107	3.24	5	89
3.31	9	89	3.25	5	96	3.11	3	94
Total	100		Total	100		Total	100	

Road Shashemene-Wolayta Sodo   width of pave(m) = 7.5   Grade(%) = 0.5
Station 120+263 to 120+387   Shoulder width (m) = 2 Left   Radius(m) = 600
Horizontal curve 120+325   = 2.4 Right   super elevation(%) = 6.9

Date :DD/MM/YY End Time: Start Time: Location: near Wolayta- Sodo Downtime: N,A Speed Lime: Weather :clear								
Passenger cars			Buses			Truck		
Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)
2.79	10	105	2.68	10	109	3.89	10	97
2.99	9	100	3.32	9	89	3.56	9	82
3.14	5	90	3.19	5	106	3.61	5	81
3.56	12	90	2.85	12	107	3.51	12	96
3.25	6	90	3.25	6	96	3.51	6	96
2.52	10	116	2.35	10	119	3.53	10	84
2.78	9	97	3.16	9	92	3.13	9	98
2.89	8	101	2.98	8	99	3.22	8	93
2.93	7	118	3.42	7	89	3.56	7	82
3.14	9	93	3.24	9	107	3.24	9	89
3.31	7	89	3.25	7	96	3.11	7	94
2.79	9	105	2.68	9	109	3.89	9	97
Total	100		Total	100		Total	100	

Road Shashemene-Asela width of pave(m) = 7.5 Grade(%) = 1.1 Station 3+306 to 3+556 Shoulder width (m) = 2 Left Radius(m) = 600 Horizontal curve 3+431 = 2.4 Right super elevation(%) = 5.3 Date :DD/MM/YY End Time: Start Time: Location: nearShashemene Downtime: N,A Speed Lime: Weather :clear								
Passenger cars			Buses			Truck		
Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)
2.79	8	105	2.68	3	113	3.88	3	95
2.99	4	100	3.32	4	89	3.56	3	82
3.14	6	90	3.19	2	106	3.61	2	81
3.56	5	90	2.85	5	107	3.51	5	96
3.56	5	90	2.85	5	107	3.51	5	96
2.52	7	116	2.35	7	119	3.53	7	84
3.12	10	90	3.3	5	96	3.41	5	96
3.12	3	96	3.34	3	96	3.41	3	96
2.78	6	97	3.16	5	92	3.13	6	98
2.89	9	101	2.98	2	99	3.22	2	93
2.93	3	118	3.42	3	89	3.56	3	82
3.14	4	93	3.24	4	107	3.24	5	89
3.31	4	89	3.25	5	96	3.11	3	94
2.79	10	105	2.68	3	109	3.89	3	98
Total	100		Total	100		Total	100	

Road Shashemene-Asela			width of pave(m) = 7.5			Grade(%) = 2.1		
Station 5+462 to 5+580			Shoulder width (m) = 2 Left			Radius(m) = 375		
Horizontal curve 5+521			= 2.4 Right			super elevation(%) = 6.6		
Date :DD/MM/YY			End Time:			Start Time:		
Location: near Shashemene			Downtime: N,A					
Speed Lime:			Weather :clear					
Passenger cars			Buses			Truck		
Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)
2.49	2	117	2.58	3	115	3.88	3	76
2.99	7	100	3.32	7	89	3.56	7	86
3.10	9	95	3.19	9	106	3.61	9	81
3.26	8	90	2.85	8	107	3.51	8	96
3.25	9	90	3.25	9	96	3.55	9	93
2.52	9	116	2.35	9	119	3.53	9	84
3.12	10	94	3.3	10	96	3.86	10	76
2.79	8	105	2.98	8	99	3.89	8	75
2.79	9	105	2.98	9	99	3.89	9	97
2.53	7	114	3.32	7	110	3.56	7	83
3.24	8	90	2.64	8	108	3.21	8	94
2.99	7	102	3.32	7	89	3.56	7	82
3.14	6	93	2.86	6	106	3.61	6	85
Total	100		Total	100		Total	100	

Road Shashemene - Asela			width of pave(m) = 7.5			Grade(%) = 0.3		
Station 9+147 to 9+259			Shoulder width (m) = 2 Left			Radius(m) = 300		
Horizontal curve 9+203			= 2.4 Right			super elevation(%) = 1.3		
Date :DD/MM/YY			End Time:			Start Time:		
Location: near Dodola			Downtime: N,A					
Speed Lime:			Weather :clear					
Passenger cars			Buses			Truck		
Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)
2.49	7	117	2.58	4	115	3.88	8	76
2.99	6	100	3.32	10	89	3.56	5	86
3.10	9	95	3.19	9	106	3.61	9	81
3.26	6	90	2.85	6	107	3.51	6	96
3.25	7	90	3.25	7	96	3.55	7	93
2.52	8	116	2.35	8	119	3.53	8	84
3.12	9	94	3.3	9	96	3.86	9	76
2.79	7	105	2.98	7	99	3.89	7	75
3.31	4	89	3.25	4	96	3.11	4	96
2.79	6	108	2.68	6	109	3.89	6	98
2.79	7	105	2.68	7	113	3.88	7	95
2.99	8	102	3.32	8	89	3.56	8	82

3.14	7	93	2.86	7	106	3.61	7	85
2.49	9	117	2.58	9	115	3.88	9	76
Total	100		Total	100		Total	100	

Road Shashemene-Asela width of pave(m) = 7.5 Grade(%) = 1.4
Station 13+071 to 13+208 Shoulder width (m) = 2 Left Radius(m) = 780
Horizontal curve 13+140 = 2.4 Right super elevation(%) = 7.1
Date :DD/MM/YY End Time: Start Time:
Location: near Dodola Downtime: N,A
Speed Lime: Weather :clear

Passenger cars			Buses			Truck		
Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)
2.49	9	118	2.58	7	115	3.88	10	76
2.99	8	104	3.32	9	89	3.56	7	86
3.27	7	95	3.19	7	106	3.61	7	81
3.26	8	98	2.85	8	107	3.51	8	96
3.25	7	90	3.25	7	96	3.55	7	93
2.52	10	116	2.35	10	119	3.53	10	84
3.12	11	94	3.3	11	96	3.86	11	76
2.79	9	105	2.98	9	99	3.89	9	75
3.31	10	89	3.25	10	96	3.11	10	96
2.79	8	108	2.68	8	109	3.89	8	98
2.79	7	105	2.68	7	113	3.88	7	95
2.85	6	102	3.32	6	89	3.56	6	82
Total	100		Total	100		Total	100	

Road Shashemene-Asela width of pave(m) = 7.5 Grade(%) = 1.4
Station 18+321 to 18+746 Shoulder width (m) = 2 Left Radius(m) = 230
Horizontal curve 18 +699 = 2.4 Right super elevation(%) = 6.4
Date :DD/MM/YY End Time: Start Time:
Location: near Dodola Downtime: N,A
Speed Lime: Weather :clear

Passenger cars			Buses			Truck		
Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)
2.49	7	118	2.58	4	115	3.88	5	76
2.99	2	104	3.32	5	89	3.56	4	86
3.27	8	95	3.19	8	106	3.61	8	81
3.26	10	98	2.85	10	107	3.51	10	96
3.25	7	90	3.25	7	96	3.55	7	93
2.52	6	116	2.35	6	119	3.53	6	84
3.12	5	94	3.3	5	96	3.86	5	76
3.24	7	90	2.64	7	108	3.21	7	94

2.93	3	118	3.42	3	89	3.56	3	82
3.14	8	93	3.24	8	107	3.24	8	89
Total	100		Total	100		Total	100	

Road Shashemene-Asela Station 31+571 to 31+690 Horizontal curve 31+631 Date :DD/MM/YY Location: near Cofeli Speed Lime:			width of pave(m) = 7.5 Shoulder width (m) = 2 Left = 2.4 Right End Time: Downtime: N,A Weather :clear			Grade(%) = 4.3 Radius(m) = 230 super elevation(%) = 6.1 Start Time:		
Passenger cars			Buses			Truck		
Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)
2.96	6	102	2.59	8	102	3.3	8	102
2.69	10	100	2.92	8	100	3.4	5	100
2.96	4	100	2.84	4	100	3.2	5	100
2.99	5	89	3.25	5	89	3.51	5	89
2.53	8	96	2.87	8	96	3.32	8	96
2.65	9	113	2.61	9	113	3.40	9	113
3.25	6	115	3.32	6	115	3.39	6	115
2.68	4	110	2.97	4	1103	2.98	4	1103
2.78	9	104	2.64	9	104	3.58	9	104
2.96	6	115	2.96	6	115	3.57	6	115
2.69	10	117	3.13	10	117	3.64	10	117
2.96	4	118	3.31	4	118	3.74	4	118
2.99	11	121	3.18	11	121	3.39	11	121
2.52	8	89	2.79	8	89	3.45	8	89
Total	100		Total	100		Total	100	

Road Shashemene-Asela Station 37+680 to 37+865 Horizontal curve 37+773 Date :DD/MM/YY Location: near Dodola Speed Lime:			width of pave(m) = 7.5 Shoulder width (m) = 2 Left = 2.4 Right End Time: Downtime: N,A Weather :clear			Grade(%) = 0.2 Radius(m) = 400 super elevation(%) = 6.1 Start Time:		
Passenger cars			Buses			Truck		
Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)
2.96	11	102	2.59	11	102	3.3	11	102
2.69	12	100	2.92	12	100	3.4	12	100
3.36	4	98	2.84	4	100	3.2	4	100
2.99	5	89	3.25	5	89	3.51	5	89
2.52	3	87	2.72	3	87	3.53	3	87
3.12	4	85	3.3	4	85	3.41	4	85

2.78	7	102	3.10	7	102	3.43	7	102
3.18	6	85	2.95	6	85	3.61	6	85
3.92	10	84	3.00	10	84	3.56	10	84
2.78	3	82	2.89	3	82	3.64	3	82
2.75	4	78	2.99	4	78	3.32	4	78
3.18	7	113	2.92	7	113	3.40	7	113
2.78	8	118	2.64	8	118	3.74	8	118
2.96	6	121	2.96	6	121	3.39	6	121
2.69	10	89	3.13	10	89	3.45	10	89
Total	100		Total	100		Total	100	

Road Shashemene-Asela width of pave(m) = 7.5 Grade(%) = 3.8
Station 41+406 to 41+582 Shoulder width (m) = 2 Left Radius(m) = 456
Horizontal curve 41+494 = 2.4 Right super elevation(%) =6.5
Date :DD/MM/YY End Time: Start Time:
Location: near Dodola Downtime: N,A
Speed Lime: Weather :clea

Passenger cars			Buses			Truck		
Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)
2.76	9	106	2.59	9	102	3.3	9	102
2.59	10	114	2.92	10	109	3.4	10	96
2.39	4	122	2.84	4	116	3.2	4	87
2.99	5	100	3.25	5	89	3.51	5	89
2.52	7	116	2.72	7	87	3.53	7	87
3.12	4	94	3.3	4	85	3.41	4	85
2.78	7	105	3.10	7	102	3.43	7	102
3.18	6	91	2.95	6	85	3.61	6	85
3.92	10	84	3.00	10	84	3.56	10	84
2.78	3	106	2.89	3	99	3.64	3	110
2.75	4	104	2.99	4	104	3.32	4	104
2.68	7	109	2.92	7	120	3.40	7	87
2.47	6	118	2.76	6	119	3.39	6	99
2.53	8	116	2.87	8	118	2.98	8	106
2.65	6	121	2.61	6	120	3.58	6	98
3.25	12	90	3.32	12	89	3.57	12	89
Total	100		Total	100		Total	100	

Road Shashemene-Asela width of pave(m) = 7.5 Grade(%) = 4.5
Station 52+253 to 52+588 Shoulder width (m) = 2 Left Radius(m) = 432
Horizontal curve 52+421 = 2.4 Right super elevation(%) = 6.9
Date :DD/MM/YY End Time: Start Time:
Location: near Dodola Downtime: N,A
Speed Lime: Weather :clear

Passenger cars			Buses			Truck		
Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)
2.76	9	106	2.69	9	108	3.3	8	102
2.59	10	114	2.92	14	101	3.4	9	96
2.39	4	122	2.84	4	116	3.2	6	87
2.99	5	100	3.25	5	89	3.51	5	89
2.52	7	116	2.72	7	87	3.53	7	87
3.12	8	94	3.3	8	85	3.41	4	85
2.78	7	105	3.10	7	102	3.43	8	102
3.18	6	91	2.95	6	85	3.61	6	85
3.92	10	84	3.00	10	84	3.56	9	84
2.78	6	106	2.89	3	99	3.64	3	110
2.75	4	104	2.99	4	104	3.32	4	89
2.68	7	109	2.92	7	120	3.40	7	87
2.47	6	118	2.76	6	119	3.39	6	99
2.53	8	116	2.87	8	118	2.98	8	106
2.65	9	121	2.61	8	120	3.58	6	98
Total	100		Total	100		Total	100	

Road Shashemene-Asela | width of pave(m) = 7.5 | Grade(%) = 4.1
Station 61+880 to 62+133 | Shoulder width (m) = 2 Left | Radius(m) = 860
Horizontal curve 62+007 | = 2.4 Right | super elevation(%) = 5.9
Date :DD/MM/YY | End Time: | Start Time:
Location: near hasasa | Downtime: N,A
Speed Lime: | Weather :clear

Passenger cars			Buses			Truck		
Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)
2.76	4	106	2.69	2	108	3.38	4	102
2.59	2	114	2.92	6	101	3.49	2	96
2.39	4	122	2.84	4	116	3.27	4	87
2.99	5	100	3.25	5	89	3.51	5	89
2.52	7	116	2.72	7	87	3.53	10	87
3.12	8	94	3.3	8	85	3.41	8	85
2.78	7	105	3.10	7	102	3.43	7	102
3.18	6	91	2.95	8	85	3.61	6	85
3.92	5	84	3.00	5	84	3.56	5	84
2.78	6	106	2.89	6	99	3.64	6	110
2.75	4	104	2.99	4	104	3.32	4	89
2.68	7	109	2.92	7	120	3.40	7	87
2.39	4	122	2.84	6	116	3.2	3	87
Total	100		Total	100		Total	100	

Road Shashemene-Asela Station 81+249 to 81+499 Horizontal curve 81+374 Date :DD/MM/YY Location: near hasasa Speed Lime:			width of pave(m) =7.5 Shoulder width (m) = 2 Left = 2.4 Right End Time: Downtime: N,A Weather :clear			Grade(%) = 3.5 Radius(m) = 982 super elevation(%) = 4.5 Start Time:		
Passenger cars			Buses			Truck		
Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)
2.78	4	106	2.79	2	104	3.38	4	102
2.89	2	112	2.92	6	101	3.49	2	96
2.39	4	122	2.84	4	116	3.27	4	87
2.99	5	100	3.25	5	89	3.51	5	89
2.52	7	116	2.72	7	87	3.53	10	87
3.12	8	94	3.3	8	85	3.41	8	85
2.78	7	105	3.10	7	102	3.43	7	102
3.18	6	91	2.95	8	85	3.61	6	85
3.92	5	84	3.00	5	84	3.56	5	84
2.78	6	106	2.89	6	99	3.64	6	110
2.75	4	104	2.99	4	104	3.32	4	89
2.68	7	109	2.92	7	116	3.40	7	87
Total	100		Total	100		Total	100	

Road Shashemene-Asela Station 82+968 to 83+176 Horizontal curve 83+072 Date :DD/MM/YY Location: near Merero Speed Lime:			width of pave(m) = 7.5 Shoulder width (m) = 2 Left = 2.4 Right End Time: Downtime: N,A Weather :clear			Grade(%) = 2.1 Radius(m) = 950 super elevation(%) = 6.3 Start Time:		
Passenger cars			Buses			Truck		
Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)
2.76	10	106	2.59	8	102	3.55	8	87
2.83	5	107	2.92	5	115	3.76	7	83
2.87	4	98	2.84	4	116	3.2	4	99
2.99	11	89	3.25	7	89	3.51	10	89
2.52	6	87	2.72	6	87	3.53	7	87
3.12	4	85	3.3	4	85	3.41	4	85
2.78	7	102	3.10	7	102	2.43	7	93
3.18	6	85	2.95	6	85	3.61	6	85
3.92	5	84	3.00	5	84	3.56	5	84
2.46	10	109	2.59	10	102	3.55	8	87
2.76	5	107	2.92	5	100	3.76	7	83
Total	100		Total	100		Total	100	

Road Shashemene-Asela Station 102+306 to 102+502 Horizontal curve 102+404 Date :DD/MM/YY Location: near Meraro Speed Lime:			width of pave(m) = 7.5 Shoulder width (m) = 2 Left = 2.4 Right End Time: Downtime: N,A Weather :clear			Grade(%) = 1.3 Radius(m) = 672 super elevation(%) =5.9 Start Time:		
Passenger cars			Buses			Truck		
Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)
2.76	10	106	2.59	10	102	3.55	8	87
2.69	5	107	2.92	5	100	3.76	7	83
2.96	4	98	2.84	4	100	3.2	4	99
2.99	11	89	3.25	5	89	3.51	10	89
2.52	6	87	2.72	6	87	3.53	7	87
3.12	4	85	3.3	4	85	3.41	4	85
2.78	7	102	3.10	7	102	2.43	7	102
3.18	6	85	2.95	6	85	3.61	6	85
3.92	5	84	3.00	5	84	3.56	5	84
2.78	8	82	2.89	8	82	3.64	8	82
2.75	4	78	2.99	7	78	3.32	9	78
3.18	12	85	2.92	12	85	3.40	7	85
3.01	10	95	2.76	10	95	3.39	10	95
2.53	8	108	2.87	8	96	2.98	8	96
Total	100		Total	100		Total	100	

Road Shashemene-Asela Station 122+484 to 122+784 Horizontal curve 122+634 Date :DD/MM/YY Location: near Meraro Speed Lime:			width of pave(m) = 7.5 Shoulder width (m) = 2 Left = 2.4 Right End Time: Downtime: N,A Weather :clear			Grade(%) = 2.4 Radius(m) = 900 super elevation(%) = 6.7 Start Time:		
Passenger cars			Buses			Truck		
Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)
2.78	11	102	3.10	10	102	3.43	9	102
3.18	6	85	2.95	7	85	3.61	8	85
3.92	9	84	3.00	9	84	3.56	9	84
2.78	6	82	2.89	6	82	3.64	6	82
2.75	8	78	2.99	8	78	3.32	8	78
3.18	7	85	2.92	7	85	3.40	7	85
3.01	11	95	2.76	11	95	3.39	11	95
2.53	10	96	2.87	10	96	2.98	10	96
2.96	6	115	2.96	6	115	2.59	6	102
2.69	5	117	3.13	5	117	3.45	5	96
2.96	9	118	3.31	9	118	3.81	9	79

2.99	5	121	3.18	5	121	3.52	5	89
2.52	7	89	2.79	7	89	3.69	7	89
Total	100		Total	100		Total	100	

Road Shashemene-Asela width of pave(m) = 7.5 Grade(%) = 4.00
Station 123+284 to 123+484 Shoulder width (m) = 2 Left Radius(m) = 864
Horizontal curve 123+384 = 2.4 Right super elevation(%) =7.6
Date :DD/MM/YY End Time: Start Time:
Location: near Bekoji Downtime: N,A
Speed Lime: Weather :clear

Passenger cars			Buses			Truck		
Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)
2.86	6	102	2.58	5	106	3.38	6	89
2.38	5	114	2.82	5	113	3.49	5	85
2.56	4	105	2.84	4	107	3.26	4	79
2.32	7	120	3.25	8	89	3.51	7	89
2.48	8	106	2.89	8	82	3.64	8	82
2.75	4	78	2.99	4	78	3.32	4	78
3.18	7	85	2.92	7	85	3.40	7	85
3.01	3	95	2.76	7	95	3.39	3	95
2.56	4	105	2.84	4	107	3.26	4	79
2.39	5	120	3.25	5	89	3.51	5	89
2.48	8	106	2.89	4	82	3.64	8	82
Total	100		Total	100		Total	100	

Road Shashemene-Asela width of pave(m) = 7.5 Grade(%) = 1.8
Station 127+131 to 127+370 Shoulder width (m) = 2 Left Radius(m) = 627
Horizontal curve 127+251 = 2.4 Right super elevation(%) = 6.1
Date :DD/MM/YY End Time: Start Time:
Location: near Bekoji Downtime: N,A
Speed Lime: Weather :clear

Passenger cars			Buses			Truck		
Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)
2.86	6	102	2.58	7	106	3.38	6	89
2.99	5	100	2.92	4	113	3.49	5	85
2.56	4	105	2.84	4	107	3.26	6	79
2.39	15	120	3.25	15	89	3.51	13	89
2.48	8	106	2.89	11	82	3.64	8	82
2.75	4	78	2.99	7	78	3.32	4	78
3.18	7	85	2.92	7	85	3.40	7	85
3.01	13	95	2.76	7	95	3.39	8	95
2.53	8	96	2.87	8	96	2.98	8	96

2.65	3	113	2.61	3	113	3.58	8	101
2.85	9	107	2.52	9	115	3.57	9	84
2.31	5	121	2.47	8	123	3.64	5	96
2.52	13	109	2.64	10	89	3.74	13	89
Total	100		Total	100		Total	100	

Road Shashemene-Asela width of pave(m) = 7.5 Grade(%) = 1.8
Station 128+891 to 129+080 Shoulder width (m) = 2 Left Radius(m) = 900
Horizontal curve 128+986 = 2.4 Right super elevation(%) = 8.1
Date :DD/MM/YY End Time: Start Time:
Location: near Bekoji Downtime: N,A
Speed Lime: Weather :clear

Passenger cars			Buses			Truck		
Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)
2.99	8	103	2.59	5	102	3.39	5	97
2.12	2	121	2.92	2	100	3.43	5	98
2.95	8	100	2.84	8	100	3.25	8	99
2.56	4	112	3.25	4	112	3.51	5	89
2.52	3	107	2.72	5	107	2.51	2	89
3.12	4	85	3.3	4	85	3.41	4	85
2.78	7	95	3.10	7	95	3.43	7	95
3.18	11	96	2.95	11	96	3.61	11	96
3.92	5	113	3.00	5	113	2.56	5	113
2.78	3	115	2.89	3	115	2.64	3	115
2.56	4	110	2.99	4	103	3.32	4	86
3.18	3	104	2.92	5	104	3.40	3	104
3.01	9	115	2.76	9	115	2.89	9	96
2.53	7	117	2.87	7	117	2.98	7	103
2.65	7	118	2.61	7	118	3.58	7	98
2.15	6	121	3.32	6	121	2.95	6	104
2.87	9	102	2.97	7	89	3.64	9	89
Total	100		Total	100		Total	100	

Road Shashemene-Asela width of pave(m) = 7.5 Grade(%) = 1.6
Station 130+804 to 131+171 Shoulder width (m) = 2 Left Radius(m) = 540
Horizontal curve 130+988 = 2.4 Right super elevation(%) = 5.8
Date :DD/MM/YY End Time: Start Time:
Location: near Asesa Downtime: N,A
Speed Lime: Weather :clear

Passenger cars			Buses			Truck		
Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)
2.85	9	103	2.59	7	102	3.39	7	97

2.12	8	121	2.92	8	100	3.43	10	98
2.95	9	100	2.84	9	100	3.25	9	99
2.56	4	112	3.25	6	112	3.51	4	89
2.52	7	107	2.72	7	107	2.51	7	107
3.12	5	85	3.3	5	85	3.41	5	85
2.53	7	117	2.87	7	117	2.98	7	110
2.65	9	118	2.61	9	118	3.58	9	98
2.15	6	121	3.32	6	121	2.95	6	104
2.67	4	105	2.97	4	89	3.64	4	89
2.95	8	102	2.59	8	102	3.34	8	102
2.12	10	121	2.92	10	100	3.43	10	98
2.95	8	100	2.84	8	100	3.25	8	99
2.56	6	112	3.25	6	112	3.51	6	89
Total	100		Total	100		Total	100	

Road Shashemene -Asela width of pave(m) = 7.5 Grade(%) = 2.11
Station 142+892 to 143+438 Shoulder width (m) = 2 Left Radius(m) = 850
Horizontal curve :123+165 = 2.4 Right super elevation(%) = 3.25
Date :DD/MM/YY End Time: Start Time:
Location: near Sagure Downtime: N,A
Speed Lime: Weather :clear

Passenger cars			Buses			Truck		
Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)
2.95	12	102	2.59	10	102	3.34	11	102
2.12	9	121	2.92	9	100	3.43	10	98
2.95	11	100	2.84	11	100	3.25	11	99
2.56	4	112	3.25	6	112	3.51	4	89
2.52	7	107	2.72	7	107	3.53	7	107
3.12	4	85	3.3	4	85	3.41	4	85
2.78	10	95	3.10	10	95	3.43	10	95
3.18	6	96	2.95	6	96	3.61	6	96
3.92	10	113	3.00	10	113	3.56	10	113
2.78	8	115	2.89	8	115	3.64	8	115
2.15	6	121	3.32	6	121	2.95	6	104
2.67	13	105	2.97	13	89	3.64	13	89
Total	100		Total	100		Total	100	

A2. Data Collection from Field for Tangent Section

Road Shashemene-Wolayta Sodo width of pave(m) = 7.5 Grade(%) = 1.12
Station 2+517to 4+722 Shoulder width (m) = 2 Left Tangent(m) = 1000
Tangent Station 3+017 = 2.4 Right Date :DD/MM/YY

End Time: Start Time: Location: near Shashemene Downtime: N,A Speed Lime: Weather :clear								
Passenger cars			Buses			Truck		
Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)
2.45	8	119	2.63	7	110	2.39	7	122
2.72	9	108	2.34	10	125	2.64	9	111
2.95	6	99	2.54	6	116	2.79	6	105
2.29	5	127	2.71	5	109	3.01	6	99
2.52	6	116	2.32	6	126	2.83	6	103
2.43	11	120	2.81	11	104	2.74	11	107
2.78	9	105	2.65	9	111	2.85	9	102
2.38	6	123	2.47	6	118	2.65	6	110
2.53	7	115	2.51	7	117	2.39	7	122
2.65	9	110	2.83	9	103	2.76	9	106
2.71	6	108	2.22	6	129	2.46	6	119
2.62	10	113	2.59	9	114	2.59	11	113
2.28	8	128	2.29	9	127	2.89	7	101
Total	100		Total	100		Total	100	

Road Shashemene-Wolayta Sodo width of pave(m) = 7.5 Grade(%) = 2.9 Station 4+412 to 5+744 Shoulder width (m) = 2 Left Tangent(m) = 1650 Tangent Station 5+237 = 2.4 Right Date :DD/MM/YY End Time: Start Time: Location: near Shashemene Downtime: N,A Speed Lime: Weather :clear								
Passenger cars			Buses			Truck		
Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)
2.45	8	119	2.63	7	110	2.39	7	122
2.72	9	108	2.34	10	125	2.64	9	111
2.95	6	99	2.54	6	116	2.79	6	105
2.29	5	127	2.71	5	109	3.01	6	99
2.52	6	116	2.32	6	126	2.83	6	103
2.43	11	120	2.81	11	104	2.74	11	107
2.78	9	105	2.65	9	111	2.85	9	102
2.38	6	123	2.47	6	118	2.65	6	110
2.53	7	115	2.51	7	117	2.39	7	122
2.65	9	110	2.83	9	103	2.76	9	106
2.71	6	108	2.22	6	129	2.46	6	119
2.62	10	113	2.59	9	114	2.59	11	113
2.28	8	128	2.29	9	127	2.89	7	101
2.45	8	119	2.63	7	110	2.39	7	122

Total	100		Total	100		Total	100	

Road Shashemene-Wolayta Sodo width of pave(m) = 7.5 Grade(%) =3.8
Station 6+012 to 6+262 Shoulder width (m) = 2 Left Tangent(m) = 332
Tangent Station 6+178 = 2.4 Right Date :DD/MM/YY
End Time: Start Time:
Location: near Asesa Downtime: N,A
Speed Lime: Weather :clear

Passenger cars			Buses			Truck		
Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)
2.45	4	119	2.63	7	110	2.39	7	122
2.72	5	108	2.34	10	125	2.64	9	111
2.95	6	99	2.54	6	116	2.79	6	105
2.29	5	127	2.71	5	109	3.01	6	99
2.52	6	116	2.32	6	126	2.83	6	103
2.43	11	120	2.81	11	104	2.74	11	107
2.78	9	105	2.65	9	111	2.85	9	102
2.38	6	123	2.47	6	118	2.65	6	110
2.53	7	115	2.51	7	117	2.39	7	122
2.65	9	110	2.83	9	103	2.76	9	106
2.71	6	108	2.22	6	129	2.46	6	119
2.62	10	113	2.59	9	114	2.59	11	113
2.28	8	128	2.29	9	127	2.89	7	101
2.45	8	119	2.63	7	110	2.39	7	122
Total	100		Total	100		Total	100	

Road Shashemene-Wolayta Sodo width of pave(m) = 7.5 Grade(%) = 2.5
Station 6+502 to 6+752 Shoulder width (m) = 2 Left Tangent (m) = 250
Tangent Station 6+632 = 2.4 Right Date :DD/MM/YY
End Time: Start Time:
Location: near Asesa Downtime: N,A
Speed Lime: Weather :clear

Passenger cars			Buses			Truck		
Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)
2.35	4	121	2.43	7	119	2.59	7	120
2.72	5	108	2.34	7	125	2.64	9	111
2.85	6	104	2.54	6	116	2.79	6	105
2.29	5	127	2.71	5	109	3.01	6	99
2.52	6	116	2.32	6	126	2.83	6	103
2.43	11	120	2.81	7	104	2.74	11	107
2.68	9	109	2.65	9	111	2.85	9	102
2.38	6	123	2.47	6	118	2.65	6	110

2.53	7	115	2.51	7	117	2.79	7	106
2.35	9	124	2.83	9	103	2.79	9	104
2.71	6	108	2.22	6	129	2.46	6	119
2.62	10	113	2.59	9	114	2.59	11	113
2.28	8	128	2.29	9	127	2.89	7	101
2.45	8	119	2.63	7	110	2.39	7	122
Total	100		Total	100		Total	100	

Road Shashemene-Wolayta Sodo width of pave(m) = 7.5 Grade(%) = 2.5
Station 7+458 to 9+937 Shoulder width (m) = 2 Left Tangent (m) = 540
Tangent Station 7+728 = 2.4 Right Date :DD/MM/YY
End Time: Start Time:
Location: near Asesa Downtime: N,A
Speed Lime: Weather :clear

Passenger cars			Buses			Truck		
Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)
2.35	4	121	2.43	2	119	2.59	3	120
2.72	5	108	2.34	7	125	2.64	4	111
2.85	6	104	2.54	6	116	2.79	6	105
2.29	5	127	2.71	5	109	3.01	6	99
2.52	6	116	2.32	6	126	2.83	6	103
2.43	7	120	2.81	7	104	2.74	11	107
2.68	9	109	2.65	9	111	2.85	9	102
2.38	6	123	2.47	6	118	2.65	6	110
2.53	7	115	2.51	7	117	2.79	7	106
2.35	9	124	2.83	9	103	2.79	9	104
2.71	6	108	2.22	6	129	2.46	6	119
2.62	10	113	2.59	7	114	2.59	6	113
2.28	8	128	2.29	9	127	2.89	7	101
2.45	8	119	2.63	7	110	2.39	7	122
2.35	4	121	2.43	7	119	2.59	7	120
Total	100		Total	100		Total	100	

Road Shashemene-Wolayta Sodo width of pave(m) = 7.5 Grade(%) = 0.1
Station 10+082 to 10+400 Shoulder width (m) = 2 Left Tangent(m) = 3365
Horizontal curve 11+765 = 2.4 Right Date :DD/MM/YY
End Time: Start Time:
Location: near Asesa Downtime: N,A
Speed Lime: Weather :clear

Passenger cars			Buses			Truck		
Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)
2.35	7	121	2.43	7	119	2.59	5	120

2.72	8	108	2.34	8	125	2.64	8	111
2.85	6	104	2.54	6	116	2.79	6	105
2.29	8	127	2.71	8	109	3.01	8	99
2.52	6	116	2.32	6	126	2.83	6	103
2.43	7	120	2.81	7	104	2.74	7	107
2.68	9	109	2.65	9	111	2.85	9	102
2.38	6	123	2.47	6	118	2.65	6	110
2.53	7	115	2.51	7	117	2.79	7	106
2.35	9	124	2.83	9	103	2.79	9	104
2.71	7	108	2.22	7	129	2.46	7	119
2.62	10	113	2.59	10	114	2.59	10	113
2.28	12	128	2.29	12	127	2.89	12	101
Total	100		Total	100		Total	100	

Road Shashemene-Wolayta Sodo width of pave(m) = 7.5 Grade(%) = 0.1
Station 10+625 to 13+485 Shoulder width (m) = 2 Left Tangent(m) = 2860
Horizontal curve 12+055 = 2.4 Right Date :DD/MM/YY
End Time: Start Time:
Location: near Asesa Downtime: N,A
Speed Lime: Weather :clear

Passenger cars			Buses			Truck		
Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)
2.25	7	123	2.33	7	125	2.59	7	120
2.52	8	116	2.34	8	125	2.64	8	111
2.65	6	110	2.54	6	116	2.79	6	105
2.29	3	127	2.71	3	109	3.01	3	99
2.52	6	116	2.32	6	126	2.83	6	103
2.43	7	120	2.81	7	104	2.74	7	107
2.68	9	109	2.65	9	111	2.85	9	102
2.38	6	123	2.47	6	118	2.65	6	110
2.53	7	115	2.51	7	117	2.79	7	106
2.35	9	124	2.83	9	103	2.79	9	104
2.55	7	114	2.22	7	129	2.46	7	119
2.62	3	113	2.59	3	114	2.59	3	113
2.28	7	128	2.29	7	127	2.89	7	101
2.35	7	121	2.43	7	119	2.59	7	120
2.72	8	108	2.34	8	125	2.64	8	111
Total	100		Total	100		Total	100	

Road Shashemene-Wolayta Sodo width of pave(m) = 7.5 Grade(%) = 2.5
Station 13+785 to 14+995 Shoulder width (m) = 2 Left Tangent(m) = 1210
Horizontal curve 14+380 = 2.4 Right Date :DD/MM/YY

End Time:			Start Time:					
Location: near Asesa			Downtime: N,A					
Speed Lime:			Weather :clear					
Passenger cars			Buses			Truck		
Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)
2.22	9	131	2.33	7	125	2.49	2	117
2.52	8	116	2.34	8	125	2.64	3	111
2.65	6	110	2.54	11	116	2.79	3	105
2.29	8	127	2.71	3	109	3.01	3	99
2.52	9	116	2.32	6	126	2.83	6	103
2.43	7	120	2.81	7	104	2.74	7	107
2.38	9	123	2.65	9	111	2.85	9	102
2.38	6	123	2.47	6	118	2.65	6	110
2.53	7	115	2.51	7	117	2.79	7	106
2.35	9	124	2.83	9	103	2.79	2	104
2.55	7	114	2.22	7	129	2.46	7	119
2.62	8	113	2.59	8	114	2.59	3	113
2.28	7	128	2.29	7	127	2.89	7	101
Total	100		Total	100		Total	100	

Road Shashemene-Wolayta Sodo			width of pave(m) = 7.5			Grade(%) = 0.6		
Station15+345 to 15+645			Shoulder width (m) = 2 Left			Tangent(m) = 650		
Horizontal curve 15+670			= 2.4 Right			Date :DD/MM/YY		
End Time:			Start Time:					
Location: near Asesa			Downtime: N,A					
Speed Lime:			Weather :clear					
Passenger cars			Buses			Truck		
Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)
2.22	7	131	2.33	6	125	2.49	9	117
2.52	3	116	2.34	8	125	2.54	3	118
2.65	6	110	2.54	6	116	2.79	8	105
2.29	8	127	2.71	3	109	3.01	3	99
2.52	4	116	2.32	6	126	2.83	6	103
2.43	7	120	2.81	7	104	2.74	7	107
2.38	9	123	2.65	9	111	2.85	9	102
2.38	6	123	2.47	6	118	2.65	6	110
2.53	7	115	2.51	2	117	2.79	7	106
2.35	9	124	2.83	5	103	2.79	8	104
2.55	7	114	2.22	7	129	2.46	7	119
2.62	8	113	2.59	8	114	2.59	3	113
2.28	7	128	2.29	7	127	2.89	6	101
2.22	4	131	2.33	7	125	2.49	7	117
2.52	3	116	2.34	8	125	2.64	3	111

2.35	6	125	2.54	5	116	2.79	8	105
Total	100		Total	100		Total	100	

Road Shashemene-Wolayta Sodo width of pave(m) = 7.5 Grade(%) = 0.9
Station 15+815 to16+430 Shoulder width (m) = 2 Left Tangent(m) = 700
Horizontal curve 15+965 = 2.4 Right
Date :DD/MM/YY End Time: Start Time:
Location: near Asesa Downtime: N,A
Speed Lime: Weather :clear

Passenger cars			Buses			Truck		
Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)
2.29	6	127	2.32	6	126	2.69	9	110
2.32	3	125	2.34	8	125	2.54	3	118
2.65	6	110	2.54	6	116	2.79	8	105
2.29	8	127	2.71	3	109	3.01	3	99
2.52	4	116	2.32	6	126	2.83	6	103
2.43	7	120	2.81	7	104	2.74	7	107
2.38	9	123	2.65	9	111	2.85	9	102
2.38	6	123	2.47	6	118	2.65	6	110
2.53	7	115	2.51	2	117	2.79	7	106
2.35	9	124	2.53	5	115	2.79	8	104
2.55	7	114	2.22	7	129	2.46	7	119
2.62	8	113	2.59	8	114	2.59	3	113
2.28	7	128	2.29	7	127	2.89	6	101
2.22	4	131	2.33	7	125	2.49	7	117
2.52	3	116	2.34	8	125	2.64	3	111
2.35	6	125	2.54	5	116	2.79	8	105
Total	100		Total	100		Total	100	

Road Shashemene-Wolayta Sodo width of pave(m) = 7.5 Grade(%) = 1.3
Station 16+650 to 16+975 Shoulder width (m) = 2 Left Tangent(m) = 600
Horizontal curve 16+800 = 2.4 Right Date :DD/MM/YY
End Time: Start Time:
Location: near Asesa Downtime: N,A
Speed Lime: Weather :clear

Passenger cars			Buses			Truck		
Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)
2.39	6	122	2.36	9	124	2.69	9	110
2.32	3	125	2.34	8	125	2.54	3	118
2.65	6	110	2.54	6	116	2.79	8	105
2.29	8	127	2.71	8	109	3.01	8	99
2.52	9	116	2.32	6	126	2.83	6	103

2.43	7	120	2.81	7	104	2.74	8	107
2.38	9	123	2.65	9	111	2.85	9	102
2.38	6	123	2.47	6	118	2.65	6	110
2.53	7	115	2.51	7	117	2.79	7	106
2.35	11	124	2.53	5	115	2.79	8	104
2.55	7	114	2.22	7	129	2.46	7	119
2.62	8	113	2.59	8	114	2.59	8	113
2.28	7	128	2.29	7	127	2.89	6	101
2.22	6	131	2.33	7	125	2.49	7	117
Total	100		Total	100		Total	100	

Road Shashemene-Wolayta Sodo width of pave(m) = 7.5 Grade(%) = 1.5
Station 17+299 to 18+099 Shoulder width (m) = 2 Left Tangent (m) = 800
Horizontal curve 17+699 = 2.4 Right Date :DD/MM/YY
End Time: Start Time:
Location: near Asesa Downtime: N,A
Speed Lime: Weather :clear

Passenger cars			Buses			Truck		
Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)
2.39	9	122	2.36	13	124	2.69	9	110
2.32	8	125	2.34	8	125	2.54	6	118
2.65	6	110	2.54	6	116	2.79	8	105
2.29	8	127	2.71	8	109	3.01	8	99
2.52	9	116	2.32	6	126	2.83	6	103
2.43	7	120	2.81	12	104	2.74	13	107
2.38	9	123	2.65	9	111	2.85	9	102
2.38	6	123	2.47	6	118	2.65	6	110
2.53	7	115	2.51	7	117	2.79	7	106
2.35	11	124	2.53	10	115	2.79	8	104
2.55	12	114	2.22	7	129	2.96	12	98
2.62	8	113	2.59	8	114	2.59	8	113
Total	100		Total	100		Total	100	

Road Shashemene-Wolayta Sodo width of pave(m) = 7.5 Grade(%) = 0.5
Station 18+419 to 19+119 Shoulder width (m) = 2 Left Tangent(m) = 700
Horizontal curve 18+769 = 2.4 Right Date :DD/MM/YY
End Time: Start Time:
Location: near Asesa Downtime: N,A
Speed Lime: Weather :clear

Passenger cars			Buses			Truck		
Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)
2.59	14	112	2.73	13	108	2.99	14	100

2.32	13	125	2.34	8	125	2.53	6	115
2.45	11	118	2.54	11	116	2.79	13	105
2.29	8	127	2.71	8	109	3.01	8	99
2.52	9	116	2.32	11	126	2.83	6	103
2.43	7	120	2.81	12	104	2.74	13	107
2.38	9	123	2.45	9	119	2.85	9	102
2.38	6	123	2.47	6	118	2.49	11	119
2.53	12	115	2.31	12	126	2.79	13	106
2.35	11	124	2.53	10	115	2.79	8	104
Total	100		Total	100		Total	100	

Road Shashemene-Wolayta Sodo width of pave(m) = 7.5 Grade(%) = 1.1
Station 19+265 to 20+726 Shoulder width (m) = 2 Left Tangent(m) = 1460
Horizontal curve 19+995 = 2.4 Right Date :DD/MM/YY
End Time: Start Time:
Location: near Asesa Downtime: N,A
Speed Lime: Weather :clear

Passenger cars			Buses			Truck		
Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)
2.41	8	123	2.73	3	117	2.79	4	104
2.32	3	125	2.34	8	125	2.53	6	115
2.45	11	118	2.54	2	116	2.79	3	105
2.29	8	127	2.71	9	109	3.01	8	99
2.52	9	116	2.32	11	126	2.83	6	103
2.43	7	120	2.81	2	104	2.74	3	107
2.38	9	123	2.45	9	119	2.85	9	102
2.38	6	123	2.47	6	118	2.49	11	119
2.53	12	115	2.31	12	126	2.79	3	106
2.35	11	124	2.53	10	115	2.79	8	104
2.59	4	112	2.73	3	108	2.99	14	100
2.22	3	130	2.34	8	125	2.53	4	115
2.45	2	118	2.54	11	116	2.79	13	105
2.29	8	127	2.71	8	109	3.01	8	99
Total	100		Total	100		Total	100	

Road Shashemene-Wolayta Sodo width of pave(m) = 7.5 Grade(%) = 0.4
Station 20+900 to 21+790 Shoulder width (m) = 2 Left Tangent(m) = 890
Tangent Station 21+345 = 2.4 Right Date :DD/MM/YY
End Time: Start Time:
Location: near Asesa Downtime: N,A
Speed Lime: Weather :clear

Passenger cars			Buses			Truck		
Record	Frequency	Speed	Record	Frequency	Speed	Record	Frequency	Speed

(sec)		(kph)	(sec)		(kph)	(sec)		(kph)
2.32	8	126	2.63	3	111	2.79	7	104
2.92	7	100	2.34	8	125	2.53	6	115
2.45	11	118	2.54	2	116	2.79	3	105
2.29	8	127	2.71	9	109	3.01	8	99
2.52	9	116	2.32	11	126	2.83	6	103
2.43	10	120	2.81	8	104	2.74	8	107
2.38	9	123	2.45	9	119	2.85	9	102
2.38	6	123	2.47	6	118	2.49	11	119
2.53	12	115	2.31	12	126	2.79	3	106
2.35	11	124	2.43	10	120	2.79	8	104
2.59	4	112	2.73	3	108	3.15	14	97
2.22	3	130	2.34	8	125	2.53	4	115
2.45	2	118	2.54	11	116	2.79	13	105
Total	100		Total	100		Total	100	

Road Shashemene-Wolayta Sodo width of pave(m) = 7.5 Grade(%) = 0.3
Station 22+046 to 23+106 Shoulder width (m) = 2 Left Tangent(m) = 1060
Tangent Station 22+576 = 2.4 Right
Date :DD/MM/YY End Time: Start Time:
Location: near Asesa Downtime: N,A
Speed Lime: Weather :clear

Passenger cars			Buses			Truck		
Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)
2.32	8	126	2.63	3	111	2.79	7	104
2.92	7	100	2.34	8	125	2.53	6	115
2.45	11	118	2.54	2	116	2.79	3	105
2.29	8	127	2.71	9	109	3.01	8	99
2.52	9	116	2.32	11	126	2.83	6	103
2.43	10	120	2.81	8	104	2.74	8	107
2.38	9	123	2.45	9	119	2.85	9	102
2.38	6	123	2.47	6	118	2.49	11	119
2.53	12	115	2.31	12	126	2.79	3	106
2.35	11	124	2.43	10	120	2.79	8	104
2.59	4	112	2.73	3	108	3.15	14	97
2.22	3	130	2.34	8	125	2.53	4	115
2.45	2	118	2.54	11	116	2.79	13	105
2.32	8	126	2.63	3	111	2.79	7	104
Total	100		Total	100		Total	100	

Road Shashemene-Wolayta Sodo width of pave(m) = 7.5 Grade(%) = 3.8
Station 23+706 to 27+706 Shoulder width (m) = 2 Left Tangent(m) = 1765
Tangent Station 24+606 = 2.4 Right Date :DD/MM/YY

End Time: Start Time:
Location: near Asesa Downtime: N,A
Speed Lime: Weather :clear

Passenger cars			Buses			Truck		
Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)
2.32	8	126	2.63	3	111	2.79	7	104
2.92	7	100	2.34	8	125	2.53	6	115
2.45	3	118	2.54	2	116	2.79	3	105
2.29	8	127	2.71	9	109	3.01	8	99
2.52	9	116	2.32	8	126	2.83	6	103
2.43	10	120	2.81	8	104	2.74	8	107
2.38	9	123	2.45	9	119	2.85	9	102
2.38	6	123	2.47	6	118	2.49	4	119
2.53	12	115	2.31	12	126	2.79	3	106
2.35	11	124	2.43	10	120	2.79	8	104
2.59	4	112	2.73	3	108	3.15	14	97
2.22	3	130	2.34	8	125	2.53	4	115
2.45	2	118	2.54	11	116	2.79	13	105
2.32	8	126	2.63	3	111	2.79	7	104
Total	100		Total	100		Total	100	

Road Shashemene-Wolayta Sodo width of pave(m) = 7.5 Grade(%) = 0.7
Station 28+061 to 29+826 Shoulder width (m) = 2 Left Tangent(m) = 2500
Tangent Station 29+311 = 2.4 Right Date :DD/MM/YY
End Time: Start Time:
Location: near Asesa Downtime: N,A
Speed Lime: Weather :clear

Passenger cars			Buses			Truck		
Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)
2.32	8	126	2.63	3	111	2.79	7	104
2.92	7	100	2.34	8	125	2.53	6	115
2.45	3	118	2.54	2	116	2.79	3	105
2.29	8	127	2.71	9	109	3.01	8	99
2.52	9	116	2.32	8	126	2.83	6	103
2.43	10	120	2.81	8	104	2.74	8	107
2.38	9	123	2.45	9	119	2.85	9	102
2.38	6	123	2.47	6	118	2.49	4	119
2.53	12	115	2.31	12	126	2.79	3	106
2.35	11	124	2.43	10	120	2.79	8	104
2.59	4	112	2.73	3	108	3.15	14	97
2.22	3	130	2.34	8	125	2.53	4	115
2.45	2	118	2.54	11	116	2.79	13	105
2.32	8	126	2.63	3	111	2.79	7	104

Total	100		Total	100		Total	100	

Road Shashemene-Wolayta Sodo width of pave(m) =7.5 Grade(%) =0.6
Station 30+491 to 30+741 Shoulder width (m) = 2 Left Tangent(m) = 2360
Tangent Station 31+671 = 2.4 Right Date :DD/MM/YY
End Time: Start Time:
Location: near Asesa Downtime: N,A
Speed Lime: Weather :clear

Passenger cars			Buses			Truck		
Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)
2.32	4	126	2.53	3	119	2.79	7	110
2.92	7	100	2.34	8	125	2.53	6	115
2.45	3	118	2.38	2	122	2.79	6	105
2.29	8	127	2.71	9	109	3.01	8	99
2.42	9	120	2.32	8	126	2.83	6	103
2.43	6	120	2.81	8	104	2.74	8	107
2.31	9	127	2.45	9	119	2.85	9	102
2.38	6	123	2.47	6	118	2.49	4	119
2.53	12	115	2.31	9	126	2.79	6	106
2.35	11	124	2.43	10	120	2.79	8	114
2.59	4	112	2.73	3	108	3.15	4	97
2.22	3	130	2.34	8	125	2.53	4	115
2.45	2	118	2.54	11	116	2.79	10	105
2.36	8	124	2.63	3	107	2.79	7	116
2.32	8	126	2.63	3	101	2.79	7	104
Total	100		Total	100		Total	100	

Road Shashemene-Wolayta Sodo width of pave(m) = 7.5 Grade(%) = 0.6
Station 30+901 to 33+261 Shoulder width (m) = 2 Left Tangent(m) =1220
Horizontal curve 31+511 = 2.4 Right super elevation(%) = 3.25
Date :DD/MM/YY End Time: Start Time:
Location: near Asesa Downtime: N,A
Speed Lime: Weather :clear

Passenger cars			Buses			Truck		
Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)
2.32	4	126	2.53	3	119	2.79	10	110
2.92	7	100	2.34	8	125	2.53	12	115
2.45	9	118	2.38	2	122	2.79	6	105
2.29	8	127	2.71	9	109	3.01	5	99
2.42	9	120	2.32	8	126	2.83	6	103
2.43	6	120	2.81	8	104	2.74	8	107
2.31	9	127	2.45	9	119	2.85	9	102

2.38	6	123	2.47	6	118	2.49	9	119
2.53	12	115	2.31	9	126	2.79	6	106
2.35	11	124	2.43	10	120	2.79	8	114
2.59	4	112	2.73	9	108	3.15	7	97
2.22	8	130	2.34	8	125	2.53	4	115
2.45	7	118	2.54	11	116	2.79	10	105
Total	100		Total	100		Total	100	

Road Shashemene-Wolayta Sodo   width of pave(m) = 7.5   Grade(%) = 0.6
Station 33+471 to 34+691   Shoulder width (m) = 2 Left   Tangent(m) = 780
Tangent Station 33+871   = 2.4 Right   super elevation(%) = 3.25
Date :DD/MM/YY   End Time: Start Time:
Location: near Asesa   Downtime: N,A
Speed Limit: Weather :clear

Passenger cars			Buses			Truck		
Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)
2.32	4	126	2.53	3	105	2.79	10	110
2.43	6	120	2.81	8	104	2.74	8	107
2.34	2	127	2.45	9	119	2.85	9	102
2.38	6	123	2.47	6	118	2.99	9	99
2.33	2	129	2.31	9	126	2.79	6	106
2.35	2	124	2.43	10	120	3.23	8	101
2.29	8	127	2.71	9	109	3.01	5	99
2.42	9	120	2.32	8	126	3.54	6	103
Total	100		Total	100		Total	100	

Road Shashemene-Wolayta Sodo   width of pave(m) = 7.5   Grade(%) = 1.1
Tangent Station 35+533 to 40+658   Shoulder width (m) = 2 Left   Tangent Length = 565
Station: 35+833   = 2.4 Right   super elevation(%) = 3.25
Date :DD/MM/YY   End Time: Start Time:
Location: near   Downtime: N,A
Speed Lime: Weather :clear

Passenger cars			Buses			Truck		
Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)
2.35	5	125	2.53	3	105	2.89	10	103
2.43	11	120	2.81	8	104	2.64	8	113
2.34	7	127	2.45	9	119	2.85	9	102
2.59	5	112	2.73	9	108	3.15	7	97
2.22	8	130	2.34	8	125	2.53	4	115
2.45	7	118	2.54	8	116	2.79	5	105
2.32	9	126	2.53	3	119	2.79	10	110
2.92	2	100	2.34	8	125	3.54	7	104

2.45	9	118	2.38	2	122	2.49	6	118
2.29	8	127	2.71	9	109	3.01	5	99
2.42	14	120	2.32	8	126	3.54	6	103
Total	100		Total	100		Total	100	

Road Shashemene-Wolayta Sodo width of pave(m) = 7.5 Grade(%) = 0.3
Station 41+438 to 47+318 Shoulder width (m) = 2 Left Tangent Length = 2180
Tangent Station:42+528 = 2.4 Right Date :DD/MM/YY
End Time: Start Time:
Location: near Hasasa Downtime: N,A
Speed Lime: Weather :clear

Passenger cars			Buses			Truck		
Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)
2.25	5	129	3.14	6	96	2.89	10	103
2.43	11	120	2.81	8	104	2.64	8	113
2.34	7	127	2.45	9	119	2.85	9	102
2.38	6	123	2.47	6	118	2.99	9	99
2.33	7	129	2.31	9	126	2.79	6	106
2.35	6	124	2.43	10	120	3.23	9	101
2.59	5	112	2.73	9	108	3.15	7	97
2.22	8	130	2.34	8	125	2.53	4	115
2.75	7	110	2.54	8	116	2.79	7	105
2.32	9	126	2.53	3	119	2.79	10	110
2.92	7	100	2.34	8	125	3.54	7	104
2.45	9	118	2.38	7	122	2.49	6	118
2.29	13	127	2.71	9	109	3.01	8	99
Total	100		Total	100		Total	100	

Road Shashemene-Wolayta Sodo width of pave(m) = 7.5 Grade(%) = 0.3
Station 47+540 to 57+306 Shoulder width (m) = 2 Left Tangent Length = 300
Tangent Station : 47+690 = 2.4 Right Date :DD/MM/YY
End Time: Start Time:
Location: near Hasasa Downtime: N,A
Speed Lime: Weather :clear

Passenger cars			Buses			Truck		
Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)
2.25	5	129	3.14	6	96	2.89	10	103
2.43	11	120	2.81	8	104	2.64	8	113
2.34	7	127	2.45	9	119	2.85	9	102
2.22	8	130	2.34	8	125	2.53	4	115
2.75	7	110	2.54	8	116	2.79	7	105
2.32	9	126	2.53	3	119	2.79	10	110

2.92	7	100	2.34	8	125	3.54	7	104
2.45	9	118	2.38	7	122	2.49	6	118
2.29	13	127	2.71	9	109	3.01	8	99
Total	100		Total	100		Total	100	

Road Shashemene-Wolayta Sodo width of pave(m) = 7.5 Grade(%) = 0.3
Station 57+731to 64+731 Shoulder width (m) = 2 Left Tangent Length = 530
Tangent : 58+001 = 2.4 Right Date :DD/MM/YY
End Time: Start Time:
Location: near Hasasa Downtime: N,A
Speed Lime: Weather :clear

Passenger cars			Buses			Truck		
Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)
2.25	10	129	3.14	10	96	2.89	10	103
2.43	11	120	2.81	8	104	2.64	8	113
2.34	7	127	2.45	9	119	2.85	12	102
2.38	6	123	2.47	6	118	2.99	9	99
2.33	12	129	2.31	9	126	2.79	6	106
2.35	6	124	2.43	10	120	3.23	9	101
2.59	5	112	2.73	9	108	3.15	7	97
2.22	8	130	2.34	8	125	2.53	6	115
2.75	10	110	2.54	11	116	2.79	7	105
2.32	9	126	2.53	3	119	2.79	10	110
2.92	7	100	2.34	8	125	3.54	7	104
2.45	9	118	2.38	9	122	2.49	9	118
Total	100		Total	100		Total	100	

Road Shashemene - Asela width of pave(m) = 7.5 Grade(%) = 0.1
Station 64+855 to 72+801 Shoulder width (m) = 2 Left Tangent Length = 1440
Tangent Station : 65+575 = 2.4 Right super elevation(%) = 3.25
Date :DD/MM/YY End Time: Start Time:
Location: near Kofele Downtime: N,A
Speed Lime: Weather :clear

Passenger cars			Buses			Truck		
Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)
2.29	5	125	3.14	5	121	2.89	10	109
2.43	6	120	2.81	8	104	2.64	8	113
2.34	7	127	2.45	9	119	2.85	7	102
2.38	6	123	2.47	6	117	2.99	9	99
2.33	12	129	2.31	9	126	2.79	6	106
2.35	6	124	2.43	5	120	3.23	9	101
2.59	5	112	2.73	9	108	3.15	7	107

2.26	8	128	2.34	8	125	2.53	6	115
2.75	10	110	2.54	11	116	2.79	7	105
2.32	9	126	2.53	3	119	2.79	10	110
2.92	7	100	2.34	8	125	3.54	7	104
2.45	9	118	2.38	9	122	2.49	9	118
2.25	10	129	3.14	10	96	2.89	5	103
Total	100		Total	100		Total	100	

Road Shashemene - Asela width of pave(m) =7.5 Grade(%) = 2.9 Station 73+061 to 82+769 Shoulder width (m) = 2 Left Tangent Length = 523 Tangent Station: 73+321 = 2.4 Right Date :DD/MM/YY End Time: Start Time: Location: near Kofele Downtime: N,A Speed Lime: Weather :clear								
Passenger cars			Buses			Truck		
Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)
2.29	5	125	3.14	5	121	2.89	10	109
2.43	6	120	2.81	8	104	2.64	8	113
2.34	7	127	2.45	9	119	2.85	7	102
2.38	6	123	2.47	6	117	2.99	9	99
2.33	12	129	2.31	9	126	2.79	6	106
2.35	6	124	2.43	5	120	3.23	9	101
2.59	5	112	2.73	9	108	3.15	7	107
2.26	8	128	2.34	8	125	2.53	6	115
2.75	10	110	2.54	11	116	2.79	7	105
2.32	9	126	2.53	3	119	2.79	10	110
2.92	7	100	2.34	8	125	3.54	7	104
2.45	9	118	2.38	9	122	2.49	9	118
2.25	10	129	3.14	10	96	2.89	5	103
Total	100		Total	100		Total	100	

Road Shashemene - Asela width of pave(m) = 7.5 Grade(%) = 0.3 Station 82+881 to 120+263 Shoulder width (m) = 2 Left Tangent Length = 1650 Tangent Station : 83+706 = 2.4 Right Date :DD/MM/YY End Time: Start Time: Location: near Dodola Downtime: N,A Speed Lime: Weather :clear								
Passenger cars			Buses			Truck		
Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)
2.49	5	122	3.14	5	124	2.89	10	113
2.29	6	125	2.81	8	120	2.64	8	113
2.34	7	127	2.45	9	119	2.85	7	102

2.38	6	123	2.32	6	126	2.99	9	99
2.33	12	129	2.34	9	119	2.79	6	106
2.35	6	124	2.43	5	120	3.23	9	101
2.59	5	112	2.73	9	108	3.15	7	107
2.26	8	128	2.34	8	125	2.53	6	115
2.75	10	110	2.54	11	116	2.79	7	105
2.32	9	126	2.53	3	119	2.79	10	110
2.62	7	109	2.34	8	125	3.54	7	104
2.45	9	118	2.38	9	122	2.49	9	118
2.25	10	129	3.14	10	96	2.89	5	103
Total	100		Total	100		Total	100	

Road Shashemene - Asela   width of pave(m) = 7.5   Grade(%) = 2.3
Station 3+462 to 5+462   Shoulder width (m) = 2 Left   Tangent Length = 3590
Tangent Station : 5+257   = 2.4 Right   Date :DD/MM/YY
End Time: Start Time:
Location: near Dodola   Downtime: N,A
Speed Lime: Weather :clear

Passenger cars			Buses			Truck		
Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)
2.49	5	122	3.14	5	124	2.89	10	113
2.29	6	125	2.81	8	120	2.64	8	113
2.34	7	127	2.45	9	119	2.85	7	102
2.25	10	129	3.14	10	96	2.89	5	103
2.49	5	122	3.14	5	124	2.89	10	113
Total	100		Total	100		Total	100	

Road Shashemene - Asela   width of pave(m) = 7.5   Grade(%) = 1.3
Station 5+647 to 9+147   Shoulder width (m) = 2 Left   Tangent Length = 456
Tangent Station: 5+875   = 2.4 Right   Date :DD/MM/YY
End Time: Start Time:
Location: near Hasasa   Downtime: N,A
Speed Lime: Weather :clear

Passenger cars			Buses			Truck		
Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)
2.49	5	118	3.14	5	124	2.89	10	101
2.29	6	127	2.81	8	120	2.64	8	113
2.34	7	125	2.45	4	119	2.85	7	102
2.38	6	123	2.32	6	126	2.99	9	98
2.33	7	129	2.34	9	119	2.79	6	106
2.45	9	118	2.38	9	122	2.49	9	118
2.25	10	129	3.14	10	96	2.89	5	103

2.57	5	113	3.14	5	124	2.89	5	113
Total	100		Total	100		Total	100	

Road Shashemene - Asela Station 9+250 to 13+071 Tangent Station:11+161 End Time: Location: near Hasasa Speed Lime:			width of pave(m) = 7.5 Shoulder width (m) = 2 Left = 2.4 Right Start Time: Downtime: N,A Weather :clear			Grade(%) = 2.4 Tangent(m) = 3821 Date :DD/MM/YY		
Passenger cars			Buses			Truck		
Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)
2.49	5	118	3.14	7	124	2.89	10	101
2.29	6	127	2.81	8	120	2.64	8	113
2.34	7	125	2.45	7	119	2.85	7	102
2.38	6	123	2.32	6	126	2.99	9	98
2.33	7	129	2.34	9	119	2.79	6	106
2.39	6	122	2.43	5	120	3.23	9	90
2.59	5	112	2.73	9	108	3.15	7	107
2.26	8	128	2.34	8	125	2.53	11	115
2.75	10	110	2.54	11	116	2.79	7	105
2.32	9	126	2.53	3	119	2.79	5	110
2.62	12	109	2.34	8	125	3.54	7	104
2.45	9	118	2.38	9	122	2.49	9	118
2.25	10	129	3.14	10	96	2.89	5	103
Total	100		Total	100		Total	100	

Road Shashemene - Asela Station 13+230 to 18+321 Tangent Station: 13+480 End Time: Location: near Hasasa Speed Lime:			width of pave(m) = 7.5 Shoulder width (m) = 2 Left = 2.4 Right Start Time: Downtime: N,A Weather :clear			Grade(%) = 0.9 Tangent (m) = 431 Date :DD/MM/YY		
Passenger cars			Buses			Truck		
Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)
2.49	5	118	3.14	7	124	2.89	10	101
2.29	6	127	2.81	8	120	2.64	8	113
2.34	7	125	2.45	7	119	2.85	7	102
2.37	6	123	2.32	6	126	2.99	9	98
2.44	7	120	2.34	9	119	2.49	6	117
2.39	6	122	2.43	5	120	3.23	9	90
2.59	5	112	2.73	9	108	3.15	7	107
2.26	8	128	2.34	8	125	2.53	11	115

2.75	10	110	2.54	11	116	2.79	7	105
2.32	9	126	2.53	3	119	2.79	5	110
2.62	12	109	2.34	8	125	3.54	7	104
2.45	9	118	2.38	9	122	2.47	9	118
2.25	10	129	3.14	10	96	2.89	5	103
Total	100		Total	100		Total	100	

Road Shashemene - Asela   width of pave(m) = 7.5   Grade(%) = 2.3
Station 18+571 to 31+571   Shoulder width (m) = 2 Left   Tangent(m) = 574
Tangent Station:18+871   = 2.4 Right   Date :DD/MM/YY
End Time: Start Time:
Location: near Meraro   Downtime: N,A
Speed Lime: Weather :clear

Passenger cars			Buses			Truck		
Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)
2.54	5	115	3.14	2	124	2.89	5	100
2.29	5	127	2.81	8	120	2.64	8	113
2.34	7	125	2.45	7	119	2.85	7	102
2.37	6	123	2.32	6	126	2.99	9	98
2.44	7	120	2.34	9	119	2.49	6	117
2.39	6	122	2.43	5	120	3.23	9	90
2.59	5	112	2.73	9	108	3.15	7	107
2.26	8	128	2.34	8	125	2.53	3	115
2.75	10	110	2.54	6	116	2.79	7	105
2.32	9	126	2.53	3	119	2.79	5	110
2.49	5	118	3.14	7	124	2.89	5	101
2.29	6	127	2.81	8	120	2.64	8	113
Total	100		Total	100		Total	100	

Road Shashemene - Asela   width of pave(m) = 7.5   Grade(%) = 2.1
Station 31+680to 37+680   Shoulder width (m) = 2 Left   Tangent (m) = 635
Tangent Station 32+00   = 2.4 Right   Date :DD/MM/YY
End Time: Start Time:
Location: near Meraro   Downtime: N,A
Speed Lime: Weather :clear

Passenger cars			Buses			Truck		
Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)
2.54	5	115	3.14	7	124	2.89	10	100
2.29	6	127	2.81	8	120	2.64	8	113
2.34	7	125	2.45	7	119	2.85	7	102
2.37	6	123	2.32	6	126	2.99	9	98
2.44	7	120	2.34	9	119	2.49	6	117

2.39	6	122	2.43	5	120	3.23	9	90
2.59	5	112	2.73	9	108	3.15	7	107
2.26	8	128	2.34	8	125	2.53	11	115
2.75	10	110	2.54	11	116	2.79	7	105
2.32	9	126	2.53	3	119	2.79	5	110
2.62	12	109	2.34	8	125	3.54	7	104
2.45	9	118	2.38	9	122	2.47	9	118
2.25	10	129	3.14	10	96	2.89	5	103
Total	100		Total	100		Total	100	

Road Shashemene - Asela width of pave(m) = 7.5 Grade(%) = 2.5
Station 37+880 to 41+406 Shoulder width (m) = 2 Left Tangent(m) = 736
Tangent Station 38+280 = 2.4 Right Date :DD/MM/YY
End Time: Start Time:
Location: near Meraro Downtime: N,A
Speed Lime: Weather :clear

Passenger cars			Buses			Truck		
Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)
2.54	5	115	3.14	7	124	2.89	9	100
2.29	6	127	2.81	8	120	2.64	8	113
2.34	7	125	2.45	7	119	2.85	7	102
2.37	6	123	2.32	6	126	2.99	9	98
2.44	7	120	2.34	9	119	2.49	7	117
2.39	6	122	2.43	5	120	3.23	9	90
2.59	5	112	2.73	9	108	3.15	7	107
2.26	8	128	2.34	8	125	2.53	8	115
2.75	10	110	2.54	11	116	2.79	7	105
2.32	9	126	2.53	3	119	2.79	8	110
2.62	12	109	2.34	8	125	3.54	7	104
2.45	9	118	2.38	9	122	2.47	9	118
2.25	10	129	3.14	10	96	2.89	5	103
Total	100		Total	100		Total	100	

Road Shashemene - Asela width of pave(m) = 7.5 Grade(%) = 1.7
Station 41+582 to 52+253 Shoulder width (m) = 2 Left Radius(m) = 395
Tangent Station 41+782 = 2.4 Right Date :DD/MM/YY
End Time: Start Time:
Location: near Bekoji Downtime: N,A
Speed Lime: Weather :clear

Passenger cars			Buses			Truck		
Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)

2.54	5	115	3.14	7	124	3.29	9	89
2.29	6	127	2.81	8	120	2.64	8	113
2.34	7	125	2.45	7	119	2.85	7	102
2.37	6	123	2.32	6	126	2.99	9	98
2.44	7	120	2.34	9	119	2.49	7	117
2.39	6	122	2.43	5	120	3.23	9	90
2.59	5	112	2.73	9	108	3.15	7	107
2.26	8	128	2.34	8	125	2.53	8	115
2.75	10	110	2.54	11	116	2.79	7	105
2.32	9	126	2.53	3	119	2.79	8	110
2.62	12	109	2.38	8	122	3.54	7	104
2.45	9	118	2.38	9	122	3.02	9	97
2.25	10	129	3.14	10	96	2.89	5	103
Total	100		Total	100		Total	100	

Road Shashemene - Asela — width of pave(m) = 7.5 — Grade(%) = 3.5
Station 52+588 to 61+880 — Shoulder width (m) = 2 Left — Tangent(m) = 469
Tangent Station: 52+823 — = 2.4 Right — Date :DD/MM/YY
End Time: — Start Time:
Location: near Bekoji — Downtime: N,A
Speed Lime: — Weather :clear

Passenger cars			Buses			Truck		
Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)
2.54	8	115	3.14	7	124	3.29	10	89
2.29	9	127	2.81	11	120	2.64	8	113
2.34	7	125	2.45	7	119	2.85	8	102
2.37	6	123	2.32	8	126	2.99	9	98
2.44	7	120	2.34	9	119	2.49	7	117
2.39	6	122	2.43	5	120	3.23	9	90
2.59	9	112	2.73	11	108	3.15	7	107
2.62	12	109	2.38	8	122	3.54	7	104
2.45	9	118	2.38	9	122	3.02	12	97
Total	100		Total	100		Total	100	

Road Shashemene - Asela — width of pave(m) = 7.5 — Grade(%) =1.5
Station 62+133 to 81+440 — Shoulder width (m) = 2 Left — Tangent(m) = 572
Tangent Station: 62+419 — = 2.4 Right — Date :DD/MM/YY
End Time: — Start Time:
Location: near Bekoji — Downtime: N,A
Speed Lime: — Weather :clear

Passenger cars			Buses			Truck		
Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)

2.54	5	115	3.14	7	124	3.29	10	89
2.29	4	127	2.81	11	120	2.64	9	113
2.34	7	125	2.45	7	119	2.85	8	102
2.37	6	123	2.32	8	126	2.99	11	98
2.44	7	120	2.34	9	119	2.49	7	117
2.39	6	122	2.43	5	120	3.23	9	90
2.59	9	112	2.73	4	108	3.15	7	107
2.26	8	128	2.34	8	125	2.53	8	115
2.75	10	110	2.54	11	116	2.79	9	105
2.32	9	126	2.53	6	119	2.79	12	110
2.62	12	109	2.38	8	122	3.54	7	104
2.45	9	118	2.38	9	122	3.02	12	97
2.54	8	115	3.14	7	124	3.29	10	89
Total	100		Total	100		Total	100	

Road Shashemene - Asela width of pave(m) = 7.5 Grade(%) = 1.6
Station 81+446 to 82+980 Shoulder width (m) = 2 Left Tangent(m) = 635
Tangent Station:81+766 = 2.4 Right Date :DD/MM/YY
End Time: Start Time:
Location: near Bekoji Downtime: N,A
Speed Lime: Weather :clear

Passenger cars			Buses			Truck		
Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)
2.54	5	115	3.14	7	124	3.29	10	89
2.29	4	127	2.81	11	120	2.64	9	113
2.34	7	125	2.45	7	119	2.85	8	102
2.37	6	123	2.32	8	126	2.99	11	98
2.44	7	120	2.34	9	119	2.49	7	117
2.39	6	122	2.43	5	120	3.23	9	90
2.59	9	112	2.73	4	108	3.15	7	107
2.32	9	126	2.53	6	119	2.79	12	110
2.62	12	109	2.38	8	122	3.54	7	104
2.45	9	118	2.38	9	122	3.02	12	97
Total	100		Total	100		Total	100	

Road Shashemene - Asela width of pave(m) = 7.5 Grade(%) = 2.3
Station 83+176 to 102+306 Shoulder width (m) = 2 Left Tangent(m) = 500
Tangent Station: 83+426 = 2.4 Right Date :DD/MM/YY
End Time: Start Time:
Location: near Sagure Downtime: N,A
Speed Lime: Weather :clear

Passenger cars			Buses			Truck		
Record	Frequency	Speed	Record	Frequency	Speed	Record	Frequency	Speed

(sec)		(kph)	(sec)		(kph)	(sec)		(kph)
2.84	5	103	2.65	13	110	3.29	10	89
2.29	9	127	2.81	11	120	2.64	9	113
2.34	12	125	2.45	7	119	2.85	11	102
2.37	8	123	2.32	8	126	2.99	11	98
2.44	7	120	2.34	9	119	2.49	7	117
2.39	11	122	2.43	5	120	3.23	9	90
2.59	9	112	2.73	9	108	3.15	7	107
2.26	8	128	2.34	8	125	2.53	8	115
2.75	10	110	2.54	11	116	2.79	9	105
2.32	9	126	2.53	6	119	2.79	12	110
2.62	12	109	2.38	13	122	3.54	7	104
Total	100		Total	100		Total	100	

Road Shashemene - Asela width of pave(m) = 7.5 Grade(%) = 3.8
Station 122+470 to 122+484 Shoulder width (m) = 2 Left Tangent Length = 785
Tangent Station : 122+870 = 2.4 Right Date :DD/MM/YY
End Time: Start Time:
Location: near Sagure Downtime: N,A
Speed Lime: Weather :clear

Passenger cars			Buses			Truck		
Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)
2.84	5	103	2.65	13	110	3.29	10	89
2.29	9	127	2.81	11	120	2.64	9	113
2.34	12	125	2.45	7	119	2.85	11	102
2.37	8	123	2.32	8	126	2.99	11	98
2.44	7	120	2.34	9	119	2.49	7	117
2.99	11	98	2.43	5	120	3.23	9	90
2.59	9	112	2.73	9	108	3.15	7	107
2.26	8	128	2.34	8	125	2.53	8	115
2.75	10	110	2.54	11	116	2.79	9	105
2.32	9	126	2.53	6	119	2.79	12	110
2.62	12	109	2.38	13	122	3.54	7	104
2.84	5	103	2.65	13	110	3.29	10	89
Total	100		Total	100		Total	100	

Road Shashemene - Asela width of pave(m) = 7.5 Grade(%) = 1.8
Station 122+784 to 123+212 Shoulder width (m) = 2 Left Tangent Length = 1521
Tangent Station : 123 +549 = 2.4 Right Date :DD/MM/YY
End Time: Start Time:
Location: near Sagure Downtime: N,A
Speed Lime: Weather :clear

Passenger cars	Buses	Truck

Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)
2.54	5	114	2.65	10	110	2.83	6	104
2.29	9	127	2.81	6	120	2.64	11	113
2.34	12	125	2.45	7	119	2.85	7	102
2.37	8	123	2.32	8	126	2.99	8	98
2.44	7	120	2.34	9	119	2.49	9	117
2.99	11	98	2.43	5	120	3.23	5	90
2.59	9	112	2.73	9	108	3.15	9	107
2.26	8	128	2.34	8	125	2.53	8	115
2.75	5	110	2.54	11	116	2.79	11	105
2.32	9	126	2.53	6	119	2.79	6	110
2.62	12	109	2.38	8	122	3.54	7	104
2.84	5	103	2.65	13	110	2.69	13	109
Total	100		Total	100		Total	100	

Road Shashemene - Asela width of pave(m) = 7.5 Grade(%) = 1.6 Station 128+169 to 130+804 Shoulder width (m) = 2 Left Tangent Length = 750
Tangent Station: 128+569 = 2.4 Right Date :DD/MM/YY
End Time: Start Time:
Location: near Asela Downtime: N,A
Speed Lime: Weather :clear

Passenger cars			Buses			Truck		
Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)
2.54	5	114	2.65	5	110	2.89	6	99
2.29	9	127	2.81	6	120	2.64	8	113
2.34	7	125	2.45	7	119	2.85	7	102
2.59	9	112	2.73	9	108	3.15	9	107
2.26	8	128	2.34	8	125	2.53	8	115
2.75	5	110	2.54	6	116	2.79	11	105
2.32	9	126	2.53	6	119	2.79	6	110
2.62	12	109	2.38	8	122	3.54	7	104
2.84	5	103	2.65	13	118	2.69	10	109
2.54	5	114	2.65	10	110	2.83	6	104
Total	100		Total	100		Total	100	

Road Shashemene - Asela width of pave(m) = 7.5 Grade(%) = 1.9
Station 130+939 to 142+892 Shoulder width (m) = 2 Left Tangent Length = 600
Tangent Station : 131+239 = 2.4 Right Date :DD/MM/YY
End Time: Start Time:
Location: near Asela Downtime: N,A
Speed Lime: Weather :clear

Passenger cars	Buses	Truck

Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)
2.54	7	114	2.65	5	110	2.89	9	99
2.29	9	127	2.81	11	120	2.64	8	113
2.34	7	125	2.45	7	119	2.85	7	102
2.59	9	112	2.73	10	108	3.15	9	107
2.26	8	128	2.34	8	125	2.53	8	115
2.75	5	110	2.54	6	116	2.79	11	105
2.32	9	126	2.53	6	119	2.79	6	110
2.62	12	109	2.38	8	122	3.54	8	104
2.84	5	103	2.65	13	118	2.69	10	109
Total	100		Total	100		Total	100	

Road Shashemene - Asela width of pave(m) = 7.5 Grade(%) = 1.85
Station 130+939 to 142+892 Shoulder width (m) = 2 Left Tangent Length = 678
Tangent Station : 134+239 = 2.4 Right Date :DD/MM/YY
End Time: Start Time:
Location: near Asela Downtime: N,A
Speed Lime: Weather :clear

Passenger cars			Buses			Truck		
Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)	Record (sec)	Frequency	Speed (kph)
2.54	7	114	2.65	5	110	2.89	9	99
2.29	9	127	2.81	11	120	2.64	8	113
2.34	7	125	2.45	7	119	2.85	7	102
2.26	8	128	2.34	8	125	2.53	8	115
2.75	5	110	2.54	6	116	2.79	11	105
2.32	9	126	2.53	6	119	2.79	6	110
2.62	12	109	2.38	8	122	3.54	8	104
2.84	5	103	2.65	13	118	2.69	10	109
Total	100		Total	100		Total	100	

APPENDIX B

B1. Data Analysis for 85th percentile speeds on tangent section.

Station:2+871

Passenger cars					Buses					Trucks				
V	f	Fc	Fc %	V %	V	F	Fc	Fc %	V %	V	F	Fc	Fc %	V %
119	8	8	8	8	103	9	9	9	9	99	6	6	6	6
108	9	17	17	17	104	11	20	20	20	101	7	13	13	13
99	6	23	23	23	109	5	25	25	25	102	9	22	22	22
127	5	28	28	28	110	7	32	32	32	103	6	28	28	28
116	6	34	34	34	111	9	41	41	41	105	6	34	34	34
123	6	60	60	60	117	7	63	63	63	110	6	60	60	60
115	7	67	67	67	118	6	69	69	69	111	9	69	69	69
110	9	76	76	76	125	10	79	79	79	113	11	80	80	80
108	6	82	82	82	116	6	85	85	85	119	6	86	86	86
113	10	92	92	92	127	9	94	94	94	122	7	93	93	93
128	8	100	100	100	129	6	100	100	100	122	7	100	100	100
V85 th	110				V85 th	116				V85 th	110			

Station:5+927														
Passenger cars					Buses					Trucks				
V	f	Fc	fc %	V %	V	f	Fc	Fc %	V %	V	f	Fc	Fc %	V %
99	6	6	6	6	103	9	7	7	7	99	6	7	7	7
105	9	15	15	15	104	4	11	17	17	101	7	14	16	16
108	9	24	24	24	109	5	16	23	23	102	9	23	22	22
108	6	30	30	30	110	7	23	28	28	103	6	29	28	28
110	9	39	39	39	110	7	30	34	34	105	6	35	34	34
116	6	62	62	62	116	6	54	53	53	110	6	54	60	60
119	8	70	70	70	117	7	61	60	60	111	9	63	67	67
119	8	78	78	78	118	6	67	69	69	113	11	74	76	76
120	11	89	89	89	125	10	77	75	75	119	6	80	82	82
123	6	95	95	95	126	6	83	84	84	122	7	87	93	93
127	5	100	100	100	127	9	92	93	93	122	7	94	100	100
128	8	108	108	108	129	6	98	100	100	122	7	101	100	100
V85 th	101				V85 th	109				V85 th	107			

Station:9+178														
Passenger cars					Buses					Trucks				
V	f	Fc	fc %	V %	V	f	Fc	Fc %	V %	V	f	Fc	Fc %	V %
99	6	6	6	6	103	9	7	7	7	99	6	6	6	6
105	9	15	15	15	104	4	11	17	17	101	7	13	13	13
108	5	20	20	20	109	5	16	23	23	102	9	22	22	22
108	6	26	26	26	110	7	23	28	28	103	6	28	28	28

115	7	52	52	52	114	9	48	54	54	107	4	47	47	47
116	6	58	58	58	116	6	54	60	60	110	6	53	53	53
119	4	62	62	62	117	7	61	67	67	111	9	62	62	62
119	8	70	70	70	118	6	67	76	76	113	11	73	73	73
120	11	81	81	81	125	10	77	82	82	119	6	79	79	79
123	6	87	87	87	126	6	83	91	91	122	7	86	86	86
127	5	92	92	92	127	9	92	100	100	122	7	93	93	93
128	8	100	100	100	129	6	98	100	100	122	7	100	100	100
V85 th	111				V85 th	99				V85 th	102			

Station:10+627														
Passenger cars					Buses					Trucks				
V	f	Fc	fc %	V %	V	f	Fc	Fc %	V %	V	f	Fc	Fc %	V %
104	6	4	4	4	103	9	7	7	7	99	6	7	7	7
108	5	9	9	9	104	7	14	14	14	101	7	14	16	16
108	6	15	15	15	109	5	19	20	20	102	9	23	22	22
109	9	24	20	20	110	7	26	25	25	103	6	29	28	28
113	10	34	26	26	111	9	35	31	31	104	9	38	34	34
115	7	41	37	37	114	9	44	38	38	105	6	44	45	45
116	6	47	46	46	116	6	50	47	47	106	7	51	54	54
119	8	55	52	52	117	7	57	53	53	107	11	62	60	60
120	11	66	59	59	118	6	63	60	60	110	6	68	67	67
121	4	70	68	68	119	7	70	69	69	111	9	77	76	76
123	6	76	74	74	125	7	77	75	75	113	11	88	82	82
124	9	85	84	84	126	6	83	84	84	119	6	94	93	93
127	5	90	92	92	127	9	92	93	93	120	7	101	100	100
128	8	98	100	100	129	6	98	100	100	122	7	108	107	107
V85 th	102				V85th	98				V85 th	96			

Station:13+900														
Passenger cars					Buses					Trucks				
V	f	Fc	fc %	V %	V	f	Fc	Fc %	V %	V	f	Fc	Fc %	V %
104	6	6	6	6	103	9	9	2	2	99	6	6	3	3
108	5	11	11	11	104	7	16	9	9	101	7	13	7	7
108	6	17	17	17	109	5	21	15	15	102	9	22	13	13
109	9	26	26	26	110	7	28	20	20	103	6	28	19	19
113	10	36	36	36	111	9	37	26	26	104	9	37	25	25
115	7	43	43	43	114	7	44	33	33	105	6	43	36	36
116	6	49	49	49	116	6	50	42	42	106	7	50	45	45
119	8	57	57	57	117	7	57	48	48	107	11	61	51	51

120	7	64	64	64	118	6	63	55	55	110	6	67	58	58
121	4	68	68	68	119	2	65	64	64	111	4	71	67	67
121	4	72	72	72	119	7	72	70	70	113	6	77	73	73
123	6	78	78	78	125	7	79	77	77	119	6	83	79	79
124	9	87	87	87	126	6	85	86	86	120	3	86	86	86
127	5	92	92	92	127	9	94	93	93	120	7	93	93	93
128	8	100	100	100	129	6	100	100	100	122	7	100	100	100
V85 th	89				V85 th	98				V85 th	87			

Station:16+903														
Passenger cars					Buses					Trucks				
V	f	Fc	fc %	V %	V	f	Fc	Fc %	V %	V	f	Fc	Fc %	V %
104	6	6	6	6	103	9	9	9	9	99	8	8	8	8
108	8	14	14	14	104	7	16	16	16	101	12	20	20	20
108	7	21	21	21	109	8	24	24	24	102	9	29	29	29
109	9	30	30	30	111	9	33	33	33	103	6	35	35	35
113	10	40	40	40	114	10	43	43	43	104	9	44	44	44
115	7	47	47	47	116	6	49	49	49	105	6	50	50	50
116	6	53	53	53	117	7	56	56	56	106	7	57	57	57
120	7	60	60	60	118	6	62	62	62	107	7	64	64	64
121	7	67	67	67	119	7	69	69	69	110	6	70	70	70
123	6	73	73	73	125	8	77	77	77	111	8	78	78	78
124	9	82	82	82	126	6	83	83	83	113	10	88	88	88
127	8	90	90	90	127	12	95	95	95	119	7	95	95	95
128	12	102	102	102	129	7	102	102	102	120	5	100	100	100
V85 th	112				V85 th	109				V85 th	111			

Station:19+375														
Passenger cars					Buses					Trucks				
V	f	Fc	Fc %	V %	V	f	Fc	Fc %	V %	V	f	Fc	Fc %	V %
99	6	6	6	6	103	9	6	6	6	99	6	6	6	6
105	9	15	15	15	104	11	13	13	13	101	7	13	13	13
108	9	24	24	24	109	5	22	22	22	102	9	22	22	22
108	6	30	30	30	110	7	28	28	28	103	6	28	28	28
110	9	39	39	39	111	9	34	34	34	105	6	34	34	34
113	10	49	49	49	114	9	43	43	43	106	9	43	43	43
115	7	56	56	56	116	6	54	54	54	107	11	54	54	54
116	6	62	62	62	117	7	60	60	60	110	6	60	60	60

119	8	70	70	70	118	6	69	69	69	111	9	69	69	69
120	11	81	81	81	125	10	80	80	80	113	11	80	80	80
123	6	87	87	87	126	6	86	86	86	119	6	86	86	86
127	5	92	92	92	127	9	93	93	93	122	7	93	93	93
128	8	100	100	100	129	6	100	100	100	122	7	100	100	100
V85 th	79				V85 th	96				V85 th	87			

Station:23+830														
Passenger cars					Buses					Trucks				
V	f	Fc	fc %	V %	V	f	Fc	Fc %	V %	V	f	Fc	Fc %	V %
110	6	6	6	6	103	9	9	9	9	99	3	3	3	3
113	8	14	14	14	104	7	16	16	16	101	7	10	10	10
114	7	21	21	21	109	3	19	19	19	102	9	19	19	19
115	7	28	28	28	111	9	28	28	28	103	6	25	25	25
116	8	36	36	36	114	8	36	36	36	104	2	27	27	27
116	9	45	45	45	116	11	47	47	47	105	3	30	30	30
120	7	52	52	52	117	7	54	54	54	106	7	37	37	37
123	9	61	61	61	118	6	60	60	60	107	7	44	44	44
123	6	67	67	67	125	7	67	67	67	110	6	50	50	50
124	9	76	76	76	125	8	75	75	75	111	3	53	53	53
127	8	84	84	84	126	6	81	81	81	113	3	56	56	56
128	7	91	91	91	127	7	88	88	88	117	2	58	58	58
131	9	100	100	100	129	7	95	95	95	119	7	100	100	100
V85 th	87				V85 th	89				V85 th	79			

Station:26+474														
Passenger cars					Buses					Trucks				
v	f	Fc	fc %	V %	V	f	Fc	Fc %	V %	V	f	Fc	Fc %	V %
110	3	3	3	3	104	7	7	7	7	99	3	3	3	3
113	7	10	10	10	109	3	10	10	10	101	6	9	9	9
114	9	19	19	19	111	9	19	19	19	102	9	18	18	18
115	6	25	25	25	114	8	27	27	27	103	6	24	24	24
116	8	33	33	33	115	5	32	32	32	104	8	32	32	32
116	4	37	37	37	116	6	38	38	38	105	8	40	40	40
125	6	76	76	76	125	8	74	74	74	111	3	80	80	80
125	3	79	79	79	126	6	80	80	80	113	3	83	83	83
127	6	85	85	85	126	6	86	86	86	117	7	90	90	90
128	8	93	93	93	127	7	93	93	93	118	3	93	93	93
131	7	100	100	100	129	7	100	100	100	119	7	100	100	100

V85 th	102	V85 th	101	V85 th	99

Station:28+669														
Passenger cars					Buses					Trucks				
v	f	Fc	fc %	V %	V	f	Fc	Fc %	V %	V	f	Fc	Fc %	V %
110	6	6	21	21	104	7	7	7	7	99	8	8	8	8
113	8	14	10	10	109	8	15	15	15	101	6	14	14	14
114	7	21	19	19	111	9	24	24	24	102	9	23	23	23
115	7	28	25	25	114	8	32	32	32	103	6	29	29	29
116	9	37	33	33	115	5	37	37	37	104	8	37	37	37
120	7	44	37	37	116	6	43	43	43	105	8	45	45	45
122	6	50	41	41	117	7	50	50	50	106	7	52	52	52
123	9	59	47	47	118	6	56	56	56	107	8	60	60	60
123	6	65	54	54	124	9	65	65	65	110	9	69	69	69
124	11	76	63	63	125	8	73	73	73	110	6	75	75	75
125	3	79	70	70	125	7	80	80	80	113	8	83	83	83
127	8	87	76	76	126	6	86	86	86	117	7	90	90	90
128	7	94	79	79	127	7	93	93	93	118	3	93	93	93
131	6	100	85	85	129	7	100	100	100	119	7	100	100	100
V85 th	98				V85 th	89				V85 th	79			

Station:31+739														
V	f	Fc	fc %	V %	V	f	Fc	Fc	V %	V	f	Fc	Fc %	V %
112	14	14	14	14	104	12	12	12	12	99	8	7	7	7
115	12	26	26	26	108	13	25	25	25	100	14	21	21	21
116	9	35	35	35	109	8	33	33	33	102	9	30	30	30
118	11	46	46	46	115	10	43	43	43	103	6	36	36	36
120	7	53	53	53	116	11	54	54	54	104	8	44	44	44
123	9	62	62	62	118	6	60	60	60	105	13	57	57	57
123	6	68	68	68	119	9	69	69	69	106	13	70	70	70
124	11	79	79	79	125	8	77	77	77	107	13	83	83	83
125	13	92	92	92	126	11	88	88	88	115	6	89	89	89
127	8	100	100	100	126	12	100	100	100	119	11	100	100	100
V85 th	110				V85 th	116				V85 th	109			

Station:34+446		
Passenger cars	Buses	Trucks

v	f	Fc	fc %	V %	V	f	Fc	Fc %	V %	V	f	Fc	Fc %	V %
112	3	3	3	3	104	2	2	2	2	99	8	8	8	8
115	12	15	15	15	108	3	5	5	5	99	8	16	16	16
116	9	24	24	24	109	7	12	12	12	100	14	30	30	30
118	11	35	35	35	109	8	20	20	20	102	9	39	39	39
118	2	37	37	37	115	10	30	30	30	103	6	45	45	45
120	7	44	44	44	116	2	32	32	32	104	`4	49	49	49
123	8	52	52	52	116	11	43	43	43	104	8	57	57	57
123	9	61	61	61	117	3	46	46	46	105	3	60	60	60
123	6	67	67	67	118	6	52	52	52	105	13	73	73	73
124	11	78	78	78	119	9	61	61	61	106	3	76	76	76
125	3	81	81	81	125	8	69	69	69	107	3	79	79	79
127	8	89	89	89	125	8	77	77	77	115	6	85	85	85
127	8	97	97	97	126	11	88	88	88	115	4	89	89	89
130	3	100	100	100	126	12	100	100	100	119	11	100	100	100
V85 th	111				V85 th	113				V85 th	102			

Station:37+285														
Passenger cars					Buses					Trucks				
v	f	Fc	fc %	V %	V	f	Fc	Fc %	V %	V	f	Fc	Fc %	V %
100	7	7	7	7	104	8	8	8	8	97	14	14	14	14
112	4	11	11	11	108	3	11	11	11	99	8	22	22	22
115	12	23	23	23	109	9	20	20	20	102	9	31	31	31
116	9	32	32	32	111	3	23	23	23	103	6	37	37	37
118	11	43	43	43	116	2	25	25	25	104	7	44	44	44
118	2	45	45	45	116	11	36	36	36	104	8	52	52	52
120	10	55	55	55	118	6	42	42	42	105	3	55	55	55
123	9	64	64	64	119	9	51	51	51	105	13	68	68	68
123	6	70	70	70	120	10	61	61	61	106	3	71	71	71
124	11	81	81	81	125	8	69	69	69	107	8	79	79	79
126	8	89	89	89	125	8	77	77	77	115	6	85	85	85
127	8	97	97	97	126	11	88	88	88	115	4	89	89	89
130	3	100	100	100	126	12	100	100	100	119	11	100	100	100
V85 th	112				V85 th	102				V85 th	98			

Station:29+270		
Passenger cars	Buses	Trucks

v	f	Fc	fc %	V %	V	f	Fc	Fc %	V %	V	f	Fc	Fc %	V %
100	7	7	7	7	104	8	8	8	8	97	14	14	14	14
112	4	11	11	11	108	3	11	11	11	99	8	22	22	22
115	12	23	23	23	109	9	20	20	20	102	9	31	31	31
116	9	32	32	32	111	3	23	23	23	103	6	37	37	37
118	11	43	43	43	111	3	26	26	26	104	7	44	44	44
118	2	45	45	45	116	2	28	28	28	104	8	52	52	52
120	10	55	55	55	116	11	39	39	39	104	7	59	59	59
123	9	64	64	64	118	6	45	45	45	105	3	62	62	62
123	6	70	70	70	119	9	54	54	54	105	13	75	75	75
124	11	81	81	81	120	10	64	64	64	106	3	78	78	78
126	8	89	89	89	125	8	72	72	72	107	8	86	86	86
126	8	90	90	90	125	8	80	80	80	115	6	92	92	92
127	8	97	97	97	126	11	91	91	91	115	4	96	96	96
130	3	100	100	100	126	12	100	100	100	119	6	100	100	100
V85 th	121				V85 th	115				V85 th	106			

Station:41+407														
Passenger cars					Buses					Trucks				
v	f	Fc	fc %	V %	V	f	Fc	Fc %	V %	V	f	Fc	Fc %	V %
100	7	8	8	8	104	8	3	3	3	97	14	7	7	7
112	4	12	15	15	108	3	6	11	11	99	8	15	13	13
115	12	27	14	18	109	9	15	13	13	102	9	24	16	16
116	9	23	31	22	111	3	18	22	22	103	6	30	24	24
118	3	34	41	40	111	3	21	30	30	104	7	37	30	30
118	2	43	53	51	116	2	23	38	38	104	8	45	38	38
120	10	63	54	62	116	11	34	47	47	104	7	52	47	47
123	9	63	61	60	118	6	40	53	53	105	3	55	51	51
123	6	67	76	73	119	9	49	65	65	105	13	68	54	54
124	11	87	81	87	120	10	59	75	75	106	3	71	62	62
126	8	89	85	85	125	8	67	78	78	107	8	79	76	76
126	8	90	90	90	125	8	75	86	86	115	6	85	80	80
127	8	97	97	97	126	8	83	97	97	115	4	89	93	93
130	3	100	100	100	126	12	95	100	100	119	4	100	100	100
V85 th	117				V85 th	106				V85 th	98			

Station:43+956														
Passenger cars					Buses					Trucks				
v	f	Fc	fc	V	V	f	Fc	Fc	V	V	f	Fc	Fc	V

			%	%				%	%				%	%
100	7	7	7	7	101	3	3	3	3	97	4	4	4	4
112	4	11	11	11	104	8	11	11	11	99	8	12	12	12
115	12	23	23	23	107	3	14	14	14	102	9	21	21	21
118	3	26	32	32	108	3	17	17	17	103	6	27	27	27
118	2	28	35	35	109	9	26	26	26	104	7	34	34	34
120	9	37	37	37	116	11	37	37	37	105	6	40	40	40
120	6	43	47	47	118	6	43	43	43	105	10	50	50	50
123	6	49	56	56	119	3	46	46	46	106	6	56	56	56
124	11	60	62	62	119	9	55	55	55	107	8	64	64	64
124	8	68	73	73	120	10	65	65	65	110	7	71	71	71
126	4	72	81	81	122	2	67	67	67	114	8	79	79	79
126	8	80	89	89	125	8	75	75	75	115	6	85	85	85
127	8	88	97	97	125	8	83	83	83	115	4	89	89	89
127	9	97	97	97	126	8	91	91	91	116	7	96	96	96
130	3	100	100	100	126	9	100	100	100	119	4	100	100	100
V85 th	97				V85 th	78				V85 th	76			

Station:45+724														
Passenger cars					Buses					Trucks				
v	f	Fc	fc %	V %	V	f	Fc	Fc %	V %	V	f	Fc	Fc %	V %
100	7	7	7	7	104	8	8	3	3	97	7	10	10	10
112	4	11	11	11	108	9	17	12	12	99	5	15	15	15
115	12	23	23	23	109	9	26	21	21	102	9	24	24	24
118	9	32	32	32	116	11	37	32	32	103	6	30	30	30
118	7	39	39	39	118	6	43	38	38	105	6	36	36	36
120	9	48	48	48	119	8	51	46	46	105	10	46	46	46
120	6	54	54	54	119	9	60	55	55	106	6	52	52	52
123	6	60	60	60	120	10	70	65	65	107	8	60	60	60
124	11	71	71	71	122	2	72	67	67	110	10	70	70	70
126	4	75	75	75	125	8	80	75	75	114	8	78	78	78
127	8	83	83	83	125	8	88	83	83	115	12	90	90	90
127	9	92	92	92	126	8	96	91	91	115	4	94	94	94
130	8	100	100	100	126	9	100	100	100	119	9	100	100	100
V85 th	87				V85 th	95				V85 th	83			

Station:49+176														
Passenger cars					Buses					Trucks				
v	f	Fc	fc	V	V	f	Fc	Fc	V	V	f	Fc	Fc	V

			%	%				%	%				%	%
100	2	2	2	2	104	8	8	8	8	110	10	10	10	10
112	5	7	7	7	105	3	11	11	11	107	8	18	18	18
118	7	14	14	14	108	9	20	20	20	102	9	27	27	27
118	4	18	18	18	109	9	29	29	29	99	9	36	36	36
120	6	24	24	24	116	8	37	37	37	106	6	42	42	42
120	9	33	33	33	118	6	43	43	43	101	8	50	50	50
123	6	39	39	39	119	9	52	52	52	97	7	57	57	57
124	2	41	41	41	119	3	55	55	55	115	4	61	61	61
126	4	45	45	45	120	10	65	65	65	105	5	66	66	66
126	4	49	49	49	122	2	67	67	67	110	10	76	76	76
127	2	51	51	51	125	8	75	75	75	104	7	83	83	83
127	8	59	59	59	125	8	83	83	83	105	6	89	89	89
129	2	61	61	61	126	9	92	92	92	99	5	94	94	94
130	8	100	100	100	126	8	100	100	100	103	6	100	100	100
V85 th	108				V85 th	101				V85 th	83			

Station:54+171														
Passenger cars					Buses					Trucks				
v	f	Fc	fc %	V %	V	f	Fc	Fc %	V %	V	f	Fc	Fc %	V %
100	2	2	2	2	104	8	8	8	8	97	7	7	7	7
112	5	7	7	7	105	3	11	11	11	99	9	16	16	16
118	7	14	14	14	108	9	20	20	20	99	5	21	21	21
118	9	23	23	23	109	9	29	29	29	101	8	29	29	29
120	11	34	34	34	116	8	37	37	37	102	9	38	38	38
120	14	48	48	48	118	6	43	43	43	103	10	48	48	48
127	7	77	77	77	125	8	75	75	75	110	10	82	82	82
127	8	85	85	85	125	8	83	83	83	113	8	90	90	90
129	7	92	92	92	126	9	92	92	92	115	4	94	94	94
130	8	100	100	100	126	8	100	100	100	118	6	100	100	100
V85 th	79				V85 th	76				V85 th	85			

Station:56+621														
Passenger cars					Buses					Trucks				
v	f	Fc	fc %	V %	V	f	Fc	Fc %	V %	V	f	Fc	Fc %	V %
100	7	7	7	7	96	6	6	6	6	97	7	7	7	7
110	7	14	14	14	104	8	14	14	14	99	9	16	16	16
112	5	19	19	19	108	9	23	23	23	99	8	24	24	24

118	9	28	28	28	109	9	32	32	32	101	9	33	33	33
120	#	39	39	39	116	8	40	40	40	102	9	42	42	42
123	6	45	45	45	118	6	46	46	46	103	10	52	52	52
124	6	51	51	51	119	9	55	55	55	104	7	59	59	59
126	9	60	60	60	119	3	58	58	58	105	7	66	66	66
127	7	67	67	67	120	10	68	68	68	106	6	72	72	72
127	#	80	80	80	122	7	75	75	75	110	10	82	82	82
129	5	85	85	85	125	8	83	83	83	113	8	90	90	90
129	7	92	92	92	125	8	91	91	91	115	4	94	94	94
130	8	100	100	100	126	9	100	100	100	118	6	100	100	100
V85 th	114				V85 th	105				V85 th	86			

Station:57+918														
Passenger cars					Buses					Trucks				
v	f	Fc	fc %	V %	V	f	Fc	Fc %	V %	V	f	Fc	Fc %	V %
100	7	7	7	7	96	6	6	6	6	97	7	7	7	7
110	7	14	14	14	104	8	14	14	14	99	9	16	16	16
112	5	19	19	19	108	9	23	23	23	99	8	24	24	24
118	9	28	28	28	109	9	32	32	32	101	9	33	33	33
120	11	39	39	39	116	8	40	40	40	102	9	42	42	42
123	6	45	45	45	118	6	46	46	46	103	10	52	52	52
124	6	51	51	51	119	9	55	55	55	104	7	59	59	59
126	9	60	60	60	119	3	58	58	58	105	7	66	66	66
127	7	67	67	67	120	10	68	68	68	106	6	72	72	72
127	13	80	80	80	122	7	75	75	75	110	10	82	82	82
129	5	85	85	85	125	8	83	83	83	113	8	90	90	90
129	7	92	92	92	125	8	91	91	91	115	4	94	94	94
130	8	100	100	100	126	9	100	100	100	118	6	100	100	100
V85 th	109				V85 th	105				V85 th	87			

Station:59+433														
Passenger cars					Buses					Trucks				
v	f	Fc	fc %	V %	V	f	Fc	Fc %	V %	V	f	Fc	Fc %	V %
100	7	7	7	7	96	10	10	10	10	97	7	7	7	7
110	10	17	17	17	104	8	18	18	18	99	9	16	16	16
112	5	22	22	22	108	9	27	27	27	101	9	25	25	25
118	9	31	31	31	116	11	38	38	38	102	12	37	37	37
120	11	42	42	42	118	6	44	44	44	103	10	47	47	47
123	6	48	48	48	119	9	53	53	53	104	7	54	54	54

124	6	54	54	54	119	3	56	56	56	105	7	61	61	61
126	9	63	63	63	120	10	66	66	66	106	6	67	67	67
127	7	70	70	70	122	9	75	75	75	110	10	77	77	77
129	10	80	80	80	125	8	83	83	83	113	8	85	85	85
129	12	92	92	92	125	8	91	91	91	115	6	91	91	91
130	8	100	100	100	126	9	100	100	100	118	9	100	100	100
V85 th	95				V85 th	89				V85 th	78			

Station:66+471														
Passenger cars					Buses					Trucks				
v	f	Fc	fc %	V%	V	f	Fc	Fc %	V %	V	f	Fc	F c%	V %
100	7	7	7	7	96	10	10	10	10	109	10	10	10	10
110	10	17	17	17	104	8	18	18	18	113	8	18	18	18
112	5	22	22	22	108	9	27	27	27	102	7	25	25	25
118	9	31	31	31	116	11	38	38	38	99	9	34	34	34
120	6	37	37	37	117	6	44	44	44	106	6	40	40	40
123	6	43	43	43	119	9	53	53	53	101	9	49	49	49
124	6	49	49	49	119	3	56	56	56	107	7	56	56	56
125	5	54	54	54	120	5	61	61	61	115	6	62	62	62
126	9	63	63	63	121	5	66	66	66	105	7	69	69	69
127	7	70	70	70	122	9	75	75	75	110	10	79	79	79
128	8	78	78	78	125	8	83	83	83	104	7	86	86	86
129	12	90	90	90	125	8	91	91	91	118	9	95	95	95
129	10	100	100	100	126	9	100	100	100	103	5	100	100	100
V85 th	88				V85 th	89				V85 th	83			

Station:73+173														
Passenger cars					Buses					Trucks				
v	f	Fc	fc %	V %	V	f	Fc	Fc %	V %	V	f	Fc	Fc %	V %
100	7	7	7	7	96	10	10	10	10	99	9	9	9	9
110	10	17	17	17	104	8	18	18	18	101	9	18	18	18
112	5	22	22	22	108	9	27	27	27	102	7	25	25	25
118	9	31	31	31	116	11	38	38	38	103	5	30	30	30
120	6	37	37	37	117	6	44	44	44	104	7	37	37	37
123	6	43	43	43	119	9	53	53	53	105	7	44	44	44
124	6	49	49	49	119	3	56	56	56	106	6	50	50	50
125	5	54	54	54	120	5	61	61	61	107	7	57	57	57
126	9	63	63	63	121	5	66	66	66	109	10	67	67	67
127	7	70	70	70	122	9	75	75	75	110	10	77	77	77
128	8	78	78	78	125	8	83	83	83	113	8	85	85	85

129	12	90	90	90	125	8	91	91	91	115	6	91	91	91
129	10	100	100	100	126	9	100	100	100	118	9	100	100	100
V85 th	118				V85 th	105				V85 th	94			

Station:83+459														
Passenger cars					Buses					Trucks				
v	f	Fc	fc %	V %	V	f	Fc	Fc %	V %	V	f	Fc	Fc %	V %
109	7	7	7	7	96	10	10	10	10	99	9	9	9	9
110	10	17	17	17	108	9	19	18	18	101	9	18	18	18
112	5	22	22	22	116	11	30	27	27	102	7	25	25	25
118	9	31	31	31	119	9	39	38	38	103	5	30	30	30
122	5	36	37	37	119	9	48	44	44	104	7	37	37	37
123	6	42	43	43	119	3	51	53	53	105	7	44	44	44
124	6	48	49	49	120	8	59	56	56	106	6	50	50	50
125	6	54	54	54	120	5	64	61	61	107	7	57	57	57
126	9	63	63	63	122	9	73	66	66	110	10	67	67	67
127	7	70	70	70	124	5	78	75	75	113	10	77	77	77
128	8	78	78	78	125	8	86	83	83	113	8	85	85	85
129	12	90	90	90	125	8	94	91	91	115	6	91	91	91
129	10	100	100	100	126	6	100	100	100	118	9	100	100	100
V85 th	104				V85 th	115				V85 th	89			

Station:121+107														
Passenger cars					Buses					Trucks				
v	f	Fc	fc %	V%	V	f	Fc	Fc %	V %	V	f	Fc	Fc %	V %
109	7	7	7	7	96	10	10	10	10	99	9	9	9	9
110	10	17	17	17	108	9	19	19	19	101	9	18	18	18
112	5	22	22	22	116	11	30	30	30	102	7	25	25	25
118	9	31	31	31	119	9	39	39	39	103	5	30	30	30
122	5	36	36	36	119	9	48	48	48	104	7	37	37	37
122	5	41	41	41	119	3	51	51	51	105	7	44	44	44
123	6	47	47	47	120	8	59	59	59	106	6	50	50	50
124	6	53	53	53	120	5	64	64	64	107	7	57	57	57
125	6	59	59	59	122	9	73	73	73	110	10	67	67	67
126	9	68	68	68	124	5	78	78	78	113	10	77	77	77
127	7	75	75	75	124	5	83	83	83	113	8	85	85	85
128	8	83	83	83	125	8	91	91	91	113	5	90	90	90
129	12	95	95	95	125	8	99	99	99	115	6	96	96	96
129	10	100			126	6	100	100	100	118	5	100	100	100

V85 th	87	V85 th	85	V85 th	79

Station:3+818														
Passenger cars					Buses					Trucks				
v	f	Fc	fc %	V %	V	f	Fc	Fc %	V %	V	f	Fc	Fc %	V %
109	7	7	7	7	96	10	10	10	10	101	10	10	10	10
110	10	17	17	17	108	9	19	18	18	113	8	18	18	18
112	5	22	22	22	116	11	30	22	22	102	7	25	25	25
113	5	27	27	27	119	4	34	28	28	98	9	34	34	34
118	5	32	32	32	119	9	43	37	37	106	6	40	40	40
118	9	41	41	41	119	3	46	42	42	90	9	49	49	49
122	6	47	47	47	120	8	54	51	51	107	7	56	56	56
123	6	53	53	53	120	5	59	59	59	115	6	62	62	62
125	7	60	60	60	122	9	68	70	70	105	7	69	69	69
126	9	69	69	69	124	5	73	73	73	110	5	74	74	74
127	6	75	75	75	124	5	78	81	81	104	7	81	81	81
128	8	83	83	83	125	8	86	90	90	118	9	90	90	90
129	7	90	90	90	125	8	94	100	100	103	5	95	95	95
129	10	100	100	100	126	6	100	100	100	113	5	100	100	100
V85 th	86				V85 th	78				V85 th	75			

Station:6+405														
Passenger cars					Buses					Trucks				
v	f	Fc	fc %	V %	V	f	Fc	Fc %	V %	V	f	Fc	Fc %	V %
109	12	12	12	12	96	10	10	10	10	90	9	9	9	9
110	10	22	22	22	108	9	19	19	19	98	9	18	18	18
112	5	27	27	27	116	11	30	30	30	101	10	28	28	28
127	6	75	75	75	124	7	78	78	78	110	5	72	72	72
128	8	83	83	83	125	8	86	86	86	113	8	80	80	80
129	7	90	90	90	125	8	94	94	94	115	11	91	91	91
129	10	100	100	100	126	6	100	100	100	118	9	100	100	100
V85 th	110				V85 th	95				V85 th	98			

Station:11+054														
Passenger cars					Buses					Trucks				
v	f	Fc	fc %	V %	V	f	Fc	Fc %	V %	V	f	Fc	Fc %	V %
109	12	12	12	12	96	10	10	10	10	90	9	9	9	9

110	10	22	22	22	108	9	19	19	19	98	9	18	18	18
112	5	27	27	27	116	11	30	30	30	101	10	28	28	28
118	5	32	32	32	119	7	37	37	37	102	7	35	35	35
118	9	41	41	41	119	9	46	46	46	103	5	40	40	40
120	7	48	47	47	119	3	49	49	49	104	7	47	47	47
122	6	54	53	53	120	8	57	57	57	105	7	54	54	54
123	6	60	60	60	120	5	62	62	62	107	7	61	60	60
125	7	67	69	69	122	9	71	71	71	110	5	66	67	67
126	9	76	75	75	124	7	78	78	78	113	8	74	72	72
127	6	82	83	83	125	8	86	86	86	115	11	85	80	80
128	8	90	90	90	125	8	94	94	94	117	6	91	91	91
129	10	100	100	100	126	6	100	100	100	118	9	100	100	100
V85 th	117				V85 th	119				V85 th	101			

Station:13+436														
Passenger cars					Buses					Trucks				
v	f	Fc	fc %	V %	V	f	Fc	Fc %	V %	V	f	Fc	Fc %	V %
109	7	7	7	7	96	5	5	5	5	90	9	9	9	9
118	5	41	41	41	119	3	39	39	39	103	5	40	40	40
120	7	48	48	48	120	8	47	47	47	104	7	47	47	47
122	6	54	54	54	120	5	52	52	52	105	7	54	54	54
123	6	60	60	60	120	8	60	60	60	107	7	61	61	61
125	7	67	67	67	122	9	69	69	69	110	5	66	66	66
126	9	76	76	76	124	2	71	71	71	113	8	74	74	74
127	5	81	81	81	124	7	78	78	78	113	8	82	82	82
127	6	87	87	87	125	8	86	86	86	115	3	85	85	85
128	8	95	95	95	125	8	94	94	94	117	6	91	91	91
129	5	100	100	100	126	6	100	100	100	118	9	100	100	100
V85 th	120				V85 th	105				V85 th	97			

Station:20+657														
Passenger cars					Buses					Trucks				
v	F	Fc	fc %	V %	V	f	Fc	Fc %	V %	V	f	Fc	Fc %	V %
109	12	12	12	12	96	10	10	10	10	90	9	9	9	9
110	10	22	22	22	108	9	19	19	19	98	9	18	18	18
112	5	27	27	27	116	11	30	30	30	100	10	28	28	28
115	5	32	32	32	119	7	37	37	37	102	7	35	35	35

118	9	41	41	41	119	9	46	46	46	103	5	40	40	40
120	7	48	48	48	119	3	49	49	49	104	7	47	47	47
122	6	54	54	54	120	8	57	57	57	105	7	54	54	54
123	6	60	60	60	120	5	62	62	62	107	7	61	61	61
125	7	67	67	67	122	9	71	71	71	110	5	66	66	66
126	9	76	76	76	124	7	78	78	78	113	8	74	74	74
127	6	82	82	82	125	8	86	86	86	115	11	85	85	85
128	8	90	90	90	125	8	94	94	94	117	6	91	91	91
129	10	100	100	100	126	6	100	100	100	118	9	100	100	100
V85 th	104				V85 th	107				V85 th	100			

Station:31+906														
Passenger cars					Buses					Trucks				
v	F	Fc	fc %	V %	V	f	Fc	Fc %	V %	V	f	Fc	Fc %	V %
109	12	12	12	12	108	11	11	11	11	89	10	10	10	10
110	10	22	22	22	116	11	22	22	22	90	9	19	19	19
112	9	31	31	31	119	7	29	29	29	97	12	31	31	31
115	8	39	39	39	119	9	38	38	38	98	9	40	40	40
118	9	48	48	48	119	6	44	44	44	102	8	48	48	48
120	7	55	55	55	120	11	55	55	55	104	7	55	55	55
122	6	61	61	61	120	5	60	60	60	105	7	62	62	62
123	6	67	67	67	122	8	68	68	68	107	7	69	69	69
125	7	74	74	74	122	9	77	77	77	110	8	77	77	77
126	9	83	83	83	124	7	84	84	84	113	8	85	85	85
127	9	92	92	92	125	8	92	92	92	115	8	93	93	93
128	8	100	100	100	126	8	100	100	100	117	7	100	100	100
V85 th	97				V85 th	101				V85 th	98			

Station:38+152														
Passenger cars					Buses					Trucks				
v	F	Fc	fc %	V %	V	f	Fc	Fc %	V%	V	F	Fc	Fc %	V %
109	12	12	12	12	96	7	7	7	7	89	9	9	9	9
110	10	22	22	22	108	9	16	15	15	90	9	18	17	17
112	5	27	27	27	116	7	27	22	22	97	9	27	24	24
115	5	32	32	32	119	7	34	28	28	98	9	36	33	33
118	9	41	41	41	119	9	43	37	37	102	7	43	40	40

120	7	48	48	48	119	3	46	42	42	103	5	48	49	49
122	6	54	54	54	120	8	54	51	51	104	7	55	56	56
123	6	60	60	60	120	5	59	59	59	105	7	62	64	64
125	7	67	67	67	122	8	67	70	70	107	7	69	71	71
126	9	76	76	76	122	9	76	73	73	110	8	77	79	79
127	6	82	82	82	124	7	83	81	81	113	8	85	86	86
128	8	90	90	90	125	8	91	90	90	115	8	93	95	95
129	10	100	100	100	126	6	97	100	100	117	7	100	100	100
V85 th	102				V85 th	106				V85 th	98			

Station:41+899														
Passenger cars					Buses					Trucks				
v	f	Fc	fc %	V %	V	f	Fc	Fc %	V %	V	f	Fc	Fc %	V %
109	12	12	12	12	108	4	4	4	4	89	10	10	10	10
110	10	22	22	22	116	11	15	15	15	90	9	19	19	19
112	9	31	31	31	119	7	22	22	22	97	12	31	31	31
115	5	36	39	39	119	9	31	31	31	98	11	42	42	42
118	9	45	48	48	119	6	37	37	37	102	8	50	50	50
120	7	52	55	55	120	11	48	48	48	104	7	57	57	57
122	6	58	61	61	120	5	53	53	53	105	9	66	66	66
123	6	64	67	67	122	8	61	61	61	107	7	73	73	73
125	7	71	74	74	122	9	70	70	70	110	12	85	85	85
126	9	80	83	83	124	7	77	77	77	113	9	85	85	85
127	4	84	92	92	125	8	85	85	85	115	8	95	95	95
128	8	100	100	100	126	8	100	100	100	117	5	100	100	100
V85 th	98				V85 th	96				V85 th	89			

Station:52+956														
Passenger cars					Buses					Trucks				
v	f	Fc	fc %	V %	V	f	Fc	Fc %	V %	V	f	Fc	Fc %	V %
103	5	5	5	5	108	9	9	9	9	89	10	10	10	10
109	12	17	17	17	110	13	22	22	22	113	9	19	19	19
110	10	27	27	27	116	11	33	33	33	102	11	30	30	30
112	9	36	36	36	119	7	40	40	40	98	11	41	41	41
120	7	43	43	43	119	9	49	49	49	117	7	48	48	48

122	11	54	54	54	119	6	55	55	55	90	9	57	57	57
123	8	62	62	62	120	11	66	66	66	107	7	64	64	64
125	12	74	74	74	120	5	71	71	71	115	8	72	72	72
126	9	83	83	83	122	13	84	84	84	105	9	81	81	81
127	9	92	92	92	125	8	92	92	92	110	12	85	85	85
128	8	100	100	100	126	8	100	100	100	104	15	100	100	100
V85 th	114				V85 th	112				V85 th	97			

Station:62+331														
Passenger cars					Buses					Trucks				
v	f	Fc	fc %	V %	V	f	Fc	Fc %	V %	V	f	Fc	Fc %	V %
98	11	11	11	11	108	9	9	9	9	89	10	10	10	10
103	5	16	16	16	110	13	22	22	22	89	10	20	20	20
103	5	21	21	21	110	13	35	35	35	90	9	29	29	29
109	12	33	33	33	116	11	46	46	46	98	11	40	40	40
110	10	43	43	43	119	7	53	53	53	102	11	51	51	51
112	9	52	52	52	119	9	62	62	62	104	7	58	58	58
120	7	59	59	59	119	6	68	68	68	105	9	67	67	67
123	8	67	67	67	120	11	79	79	79	107	7	74	74	74
125	12	79	79	79	120	5	84	84	84	110	12	86	86	86
126	9	88	88	88	122	13	95	95	95	113	9	95	95	95
127	9	97	97	97	125	8	89	89	89	115	8	97	97	97
128	3	100	100	100	126	11	100	100	100	117	3	100	100	100
V85 th	123				V85 th	120				V85 th	101			

Station81+734														
Passenger cars					Buses					Trucks				
v	f	Fc	fc %	V%	V	f	Fc	Fc %	V %	V	f	Fc	Fc %	V %
98	11	11	11	11	108	9	9	9	9	90	5	5	5	5
103	5	16	16	16	110	10	19	19	19	98	8	13	13	13
109	12	28	28	28	110	13	32	32	32	102	7	20	20	20
110	5	33	33	33	116	11	43	43	43	104	6	26	26	26
112	9	42	42	42	119	7	50	50	50	104	7	33	33	33
114	5	47	47	47	119	9	59	59	59	105	11	44	44	44
120	7	54	54	54	119	6	65	65	65	107	9	53	53	53
123	8	62	62	62	120	6	71	71	71	109	13	66	66	66
125	12	74	74	74	120	5	76	76	76	110	6	72	72	72
126	9	83	83	83	122	8	84	84	84	113	11	83	83	83

127	9	92	92	92	125	8	92	92	92	115	8	91	91	91
128	8	100	100	100	126	8	100	100	100	117	9	100	100	100
V85 th	113				V85 th	115				V85 th	99			

Stati82+734														
Passenger cars					Buses					Trucks				
v	f	Fc	fc %	V %	V	f	Fc	Fc %	V %	V	f	Fc	Fc %	V %
98	11	11	11	11	108	10	10	10	10	90	7	7	7	7
103	5	16	16	16	110	5	15	15	15	98	8	15	15	15
109	12	28	28	28	116	6	21	21	21	99	9	24	24	24
110	5	33	33	33	118	13	34	34	34	102	7	31	31	31
112	9	42	42	42	119	7	41	41	41	104	8	39	39	39
114	7	49	47	47	119	9	50	50	50	105	11	50	50	50
120	10	59	54	54	119	6	56	56	56	107	9	59	59	59
123	8	67	62	62	120	11	67	67	67	109	10	69	69	69
125	7	74	74	74	120	5	72	72	72	110	6	75	75	75
126	9	83	83	83	122	8	80	80	80	113	8	83	83	83
127	9	92	92	92	125	8	88	88	88	115	8	91	91	91
128	8	100	100	100	126	12	100	100	100	117	9	100	100	100
V85 th	99				V85 th	103				V85 th	98			

Station:83+462														
Passenger cars					Buses					Trucks				
v	f	Fc	fc %	V %	V	f	Fc	Fc %	V %	V	F	Fc	Fc %	V %
98	11	11	11	11	108	10	10	10	10	90	7	7	7	7
103	5	16	16	16	110	5	15	15	15	98	8	15	15	15
109	12	28	28	28	116	6	21	21	21	99	9	24	24	24
110	5	33	33	33	118	13	34	34	34	102	7	31	31	31
112	9	42	42	42	119	7	41	41	41	104	8	39	39	39
114	7	49	47	47	119	9	50	50	50	105	11	50	50	50
120	10	59	54	54	119	6	56	56	56	107	9	59	59	59
123	8	67	62	62	120	11	67	67	67	109	10	69	69	69
125	7	74	74	74	120	5	72	72	72	110	6	75	75	75
126	9	83	83	83	122	8	80	80	80	113	8	83	83	83
127	9	92	92	92	125	8	88	88	88	115	8	91	91	91
128	8	100	100	100	126	12	100	100	100	117	9	100	100	100
V85 th	101				V85 th	100					98			

Station:102+820														
Passenger cars					Buses					Trucks				
v	f	Fc	fc %	V %	V	f	Fc	Fc %	V %	V	f	Fc	Fc %	V %
109	12	12	12	12	96	10	10	10	10	90	9	9	9	9
110	10	22	22	22	108	9	19	19	19	98	9	18	18	18
112	5	27	27	27	116	11	30	30	30	100	10	28	28	28
115	5	32	32	32	119	7	37	37	37	102	7	35	35	35
118	9	41	41	41	119	9	46	46	46	103	5	40	40	40
120	7	48	48	48	119	3	49	49	49	104	7	47	47	47
122	6	54	54	54	120	8	57	57	57	105	7	54	54	54
123	6	60	60	60	120	5	62	62	62	107	7	61	61	61
125	7	67	67	67	122	9	71	71	71	110	5	66	66	66
126	9	76	76	76	124	7	78	78	78	113	8	74	74	74
127	6	82	82	82	125	8	86	86	86	115	11	85	85	85
128	8	90	90	90	125	8	94	94	94	117	6	91	91	91
129	10	100	100	100	126	6	100	100	100	118	9	100	100	100
V85 th	103				V85 th	98				V85 th	89			

Station:123+634														
Passenger cars					Buses					Trucks				
v	f	Fc	fc %	V %	V	f	Fc	Fc %	V %	V	f	Fc	Fc %	V %
109	12	12	12	12	108	11	11	11	11	89	10	10	10	10
110	10	22	22	22	116	11	22	22	22	90	9	19	19	19
112	9	31	31	31	119	7	29	29	29	97	12	31	31	31
115	8	39	39	39	119	9	38	38	38	98	9	40	40	40
118	9	48	48	48	119	6	44	44	44	102	8	48	48	48
120	7	55	55	55	120	11	55	55	55	104	7	55	55	55
122	6	61	61	61	120	5	60	60	60	105	7	62	62	62
123	6	67	67	67	122	8	68	68	68	107	7	69	69	69
125	7	74	74	74	122	9	77	77	77	110	8	77	77	77
126	9	83	83	83	124	7	84	84	84	113	8	85	85	85
127	9	92	92	92	125	8	92	92	92	115	8	93	93	93
128	8	100	100	100	126	8	100	100	100	117	7	100	100	100
V85 th	110				V85 th	101				V85 th	98			

Station:123+877														
Passenger cars					Buses					Trucks				
V	f	Fc	fc	V	V	f	Fc	Fc	V%	V	f	Fc	Fc	V

			%	%				%					%	%
109	12	12	12	12	96	7	7	7	7	89	9	9	9	9
110	10	22	22	22	108	9	16	15	15	90	9	18	17	17
112	5	27	27	27	116	7	27	22	22	97	9	27	24	24
115	5	32	32	32	119	7	34	28	28	98	9	36	33	33
118	9	41	41	41	119	9	43	37	37	102	7	43	40	40
120	7	48	48	48	119	3	46	42	42	103	5	48	49	49
122	6	54	54	54	120	8	54	51	51	104	7	55	56	56
123	6	60	60	60	120	5	59	59	59	105	7	62	64	64
125	7	67	67	67	122	8	67	70	70	107	7	69	71	71
126	9	76	76	76	122	9	76	73	73	110	8	77	79	79
127	6	82	82	82	124	7	83	81	81	113	8	85	86	86
128	8	90	90	90	125	8	91	90	90	115	8	93	95	95
129	10	100	100	100	126	6	97	100	100	117	7	100	100	100
V85 th	101				V85 Th	98				V85 th	89			

Station:128+131														
Passenger cars					Buses					Trucks				
v	f	Fc	fc %	V %	V	f	Fc	Fc %	V %	V	f	Fc	Fc %	V %
109	12	12	12	12	108	4	4	4	4	89	10	10	10	10
110	10	22	22	22	116	11	15	15	15	90	9	19	19	19
112	9	31	31	31	119	7	22	22	22	97	12	31	31	31
115	5	36	39	39	119	9	31	31	31	98	11	42	42	42
118	9	45	48	48	119	6	37	37	37	102	8	50	50	50
120	7	52	55	55	120	11	48	48	48	104	7	57	57	57
122	6	58	61	61	120	5	53	53	53	105	9	66	66	66
123	6	64	67	67	122	8	61	61	61	107	7	73	73	73
125	7	71	74	74	122	9	70	70	70	110	12	85	85	85
126	9	80	83	83	124	7	77	77	77	113	9	85	85	85
127	4	84	92	92	125	8	85	85	85	115	8	95	95	95
128	8	100	100	100	126	8	100	100	100	117	5	100	100	100
V85 th	127				V85 th	125				V85 th	113			

Station:129+455														
Passenger cars					Buses					Trucks				
v	f	Fc	fc %	V %	V	f	Fc	Fc %	V %	V	f	Fc	Fc %	V %
103	5	5	5	5	108	9	9	9	9	89	10	10	10	10
109	12	17	17	17	110	13	22	22	22	113	9	19	19	19

110	10	27	27	27	116	11	33	33	33	102	11	30	30	30
112	9	36	36	36	119	7	40	40	40	98	11	41	41	41
120	7	43	43	43	119	9	49	49	49	117	7	48	48	48
122	11	54	54	54	119	6	55	55	55	90	9	57	57	57
123	8	62	62	62	120	11	66	66	66	107	7	64	64	64
125	12	74	74	74	120	5	71	71	71	115	8	72	72	72
126	9	83	83	83	122	13	84	84	84	105	9	81	81	81
127	9	92	92	92	125	8	92	92	92	110	12	85	85	85
128	8	100	100	100	126	8	100	100	100	104	15	100	100	100
V85 th	94				V85 Th	95				V85 th	89			

B2. Data Analysis for 85th percentile speeds on curves section

Station:2+249														
Passenger cars					Buses					Trucks				
v	f	Fc	fc %	V %	V	f	Fc	Fc %	V %	V	f	Fc	Fc %	V %

90	9	11	11	11	88	6	6	6	6	76	12	12	12	12
94	6	17	17	17	89	12	18	18	18	78	9	21	21	21
99	11	28	28	28	92	8	26	26	26	78	12	33	33	33
100	4	32	32	32	93	3	29	29	29	79	10	43	43	43
105	10	42	42	42	98	4	33	33	33	80	10	53	53	53
106	4	46	46	46	99	10	43	43	43	81	7	60	60	60
108	10	56	56	56	100	11	54	54	54	82	8	68	68	68
110	12	68	68	68	102	12	66	66	66	83	4	72	72	72
112	9	77	77	77	105	9	75	75	75	86	7	79	79	79
113	7	84	84	84	110	3	78	78	78	87	8	87	87	87
115	11	95	95	95	112	13	91	91	91	88	6	93	93	93
125	5	100	100	100	113	9	100	100	100	89	7	100	100	100
V85 th	85				V85 th	86				V85 th	85			

Station:4+757														
Passenger cars					Buses					Trucks				
v	f	Fc	fc %	V %	V	f	Fc	Fc %	V %	V	f	Fc	Fc %	V %
91	9	9	9	9	86	10	10	10	10	76	8	8	8	8
94	9	18	18	18	88	12	22	22	22	76	10	18	16	16
98	10	28	28	28	89	13	35	35	35	78	12	30	26	26
98	8	36	36	36	92	8	43	43	43	81	9	39	34	34
102	5	41	41	41	93	8	51	51	51	83	8	47	43	43
106	8	49	49	49	98	8	59	59	59	83	9	56	50	50
106	7	56	56	56	100	6	65	65	65	85	8	64	59	59
108	10	66	66	66	101	9	74	74	74	85	7	71	67	67
115	11	77	77	77	102	7	81	81	81	88	8	79	78	78
117	11	88	88	88	108	9	90	90	90	88	11	90	88	88
125	12	100	100	100	113	10	100	100	100	91	10	100	100	100
V85 th	111				V85 Th	105				V85 th	88			

Station:8+878														
Passenger cars					Buses					Trucks				
v	f	Fc	fc %	V %	V	f	Fc	Fc %	V %	V	f	Fc	Fc %	V %
90	11	11	11	11	88	12	12	12	12	76	12	12	12	12
92	9	20	20	20	89	7	19	19	19	78	10	22	22	22
99	10	30	30	30	92	8	27	27	27	80	9	31	31	31
100	9	39	39	39	93	9	36	36	36	82	9	40	40	40
105	10	49	49	49	93	8	44	44	44	83	10	50	50	50
108	9	58	58	58	98	11	55	55	55	85	11	61	61	61
108	10	68	68	68	98	10	65	65	65	86	8	69	69	69

109	9	77	77	77	99	10	75	75	75	87	10	79	79	79
115	11	88	88	88	103	12	87	87	87	88	11	90	90	90
125	12	100	100	100	110	13	100	100	100	89	10	100	100	100
V85 th	104				V85 Th	100				V85 th	88			

Station:10+382														
Passenger cars					Buses					Trucks				
v	f	Fc	fc %	V %	V	f	Fc	Fc %	V %	V	f	Fc	Fc %	V %
92	11	11	11	11	110	6	6	6	6	76	9	8	8	8
94	9	20	20	20	100	10	16	16	16	76	8	16	15	15
98	8	28	28	28	101	9	25	25	25	81	7	23	25	25
99	5	33	33	33	86	5	30	30	30	81	10	33	33	33
100	8	41	41	41	108	9	39	39	39	83	7	40	40	40
105	9	50	50	50	88	8	47	47	47	83	8	48	48	48
105	7	57	57	57	95	11	58	58	58	84	12	60	60	60
106	8	65	65	65	99	12	70	70	70	84	8	68	70	70
106	9	74	74	74	88	7	77	77	77	85	8	76	79	79
108	8	82	82	82	92	8	85	85	85	86	8	84	87	87
115	8	90	90	90	100	8	93	93	93	87	5	89	95	95
117	10	100	100	100	108	7	100	100	100	89	10	99	100	100
V85 th	93				V85 Th	92				V85 th	86			

Station:13+558														
Passenger cars					Buses					Trucks				
v	f	Fc	fc %	V %	V	f	Fc	Fc %	V %	V	f	Fc	Fc %	V %
89	12	12	12	12	89	7	7	7	7	67	10	10	10	10
90	7	19	19	19	99	11	18	18	18	78	12	22	22	22
99	6	25	25	25	100	9	27	27	27	78	12	34	34	34
100	5	30	30	30	104	8	35	35	35	79	11	45	45	45
100	10	40	40	40	105	14	49	49	49	83	8	53	53	53
101	8	48	48	48	109	12	61	61	61	83	10	63	63	63
104	13	61	61	61	110	12	73	73	73	84	9	72	72	72
108	9	70	70	70	115	8	81	81	81	87	11	83	83	83
110	12	82	82	82	117	5	86	86	86	88	4	87	87	87
110	10	92	92	92	118	4	90	90	90	89	7	94	94	94
115	8	100	100	100	121	10	100	100	100	94	6	100	100	100
V85 th	89				V85 Th	91				V85 th	87			

Station:15+108														
Passenger cars					Buses					Trucks				
v	f	Fc	fc %	V %	V	f	Fc	Fc %	V %	V	f	Fc	Fc %	V %
78	11	11	11	11	78	8	8	8	8	78	9	10	10	10
82	11	22	22	22	82	10	18	18	18	79	10	20	20	20
89	4	26	26	26	96	10	28	28	28	82	7	27	27	27
96	9	35	35	35	99	15	43	43	43	84	11	38	38	38
97	10	45	45	45	100	9	52	52	52	87	12	50	50	50
101	14	59	59	59	102	7	59	59	59	87	9	59	59	59
101	10	69	69	69	103	11	70	70	70	89	10	69	69	69
105	9	78	78	78	105	8	78	78	78	90	11	80	80	80
110	11	89	89	89	107	10	88	88	88	92	12	92	92	92
112	11	100	100	100	112	12	100	100	100	96	8	100	100	100
V85 th	76				V85 th	79				V85 th	74			

Station:17+795														
Passenger cars					Buses					Trucks				
v	f	Fc	fc %	V %	V	f	Fc	Fc %	V %	V	f	Fc	Fc %	V %
85	8	8	8	8	85	8	8	8	8	78	8	8	8	8
87	8	16	16	16	87	11	19	19	19	80	12	20	20	20
89	12	28	28	28	89	8	27	27	27	84	9	29	29	29
89	11	39	39	39	89	6	33	33	33	85	5	34	34	34
104	9	65	65	65	102	5	68	68	68	87	12	72	72	72
109	6	71	71	71	102	2	70	70	70	89	8	80	80	80
109	9	80	80	80	109	9	79	79	79	89	4	84	84	84
110	8	88	88	88	110	9	88	88	88	92	8	92	92	92
110	12	100	100	100	110	12	100	100	100	96	8	100	100	100
V85 th	97				V85 th	86				V85 th	78			

Station:22+828														
Passenger cars					Buses					Trucks				
v	f	Fc	fc %	V %	V	f	Fc	Fc %	V %	V	f	Fc	Fc %	V %
82	6	6	6	6	89	12	12	12	12	78	7	7	7	7
84	8	14	14	14	100	11	23	23	23	80	10	17	17	17
85	8	22	22	22	83	9	32	32	32	80	13	30	30	30
85	9	31	31	31	89	8	40	40	40	81	12	42	42	42
87	10	41	41	41	87	8	48	48	48	84	12	54	54	54
89	8	49	49	49	85	13	61	61	61	84	10	64	64	64

102	11	60	60	60	102	7	68	68	68	85	7	71	71	71
106	11	71	71	71	85	9	77	77	77	85	9	80	80	80
109	90	90	90	90	84	85	162	85	85	87	12	92	92	92
112	10	100	100	100	82	15	177	100	100	89	8	100	100	100
V85 th	72				V85 th	74				V85 th	76			

Station:26+064														
Passenger cars					Buses					Trucks				
v	f	Fc	fc %	V %	V	f	Fc	Fc %	V %	V	f	Fc	Fc %	V %
96	12	12	12	12	83	11	14	14	14	79	10	10	10	10
104	12	24	24	24	89	14	28	28	28	80	13	23	23	23
105	7	31	31	31	96	10	38	38	38	81	13	36	36	36
106	11	42	42	42	100	12	50	50	50	82	11	47	47	47
107	11	53	53	53	104	10	60	60	60	84	9	56	56	56
109	11	64	64	64	105	11	71	71	71	85	11	67	67	67
110	12	76	76	76	107	11	82	82	82	87	8	75	75	75
112	12	88	88	88	110	9	91	91	91	95	13	88	88	88
112	12	100	100	100	112	9	100	100	100	96	12	100	100	100
V85 th	89				V85 Th	87				V85 th	78			

Station:28+209														
Passenger cars					Buses					Trucks				
v	f	Fc	fc %	V %	V	f	Fc	Fc %	V %	V	f	Fc	Fc %	V %
85	9	9	9	9	83	8	8	8	8	77	7	7	7	7
87	9	18	18	18	85	10	18	18	18	80	14	21	21	21
89	11	29	29	29	87	11	29	29	29	80	9	30	30	30
96	9	38	38	38	89	11	40	40	40	81	10	40	40	40
102	13	51	51	51	89	10	50	50	50	81	9	49	49	49
106	10	61	61	61	96	11	61	61	61	84	8	57	57	57
109	12	73	73	73	100	9	70	70	70	85	10	67	67	67
109	5	78	78	78	102	9	79	79	79	87	11	78	78	78
110	12	90	90	90	109	9	88	88	88	89	10	88	88	88
112	10	100	100	100	110	12	100	100	100	96	12	100	100	100
V85 th	69				V85 Th	70				V85 th	88			

Statio:31+279														
Passenger cars					Buses					Trucks				
v	f	Fc	fc	V	V	f	Fc	Fc	V	V	f	Fc	Fc	V

			%	%				%	%				%	%
94	10	10	10	10	86	8	8	8	8	79	5	5	5	5
96	12	22	22	22	89	9	17	17	17	94	9	14	14	14
100	9	31	31	31	89	7	24	24	24	96	6	20	20	20
101	9	40	40	40	96	5	29	29	29	96	9	29	29	29
105	11	51	51	51	97	12	41	41	41	85	8	37	37	37
107	12	63	63	63	101	9	50	50	50	84	7	44	44	44
108	9	72	72	72	102	14	64	64	64	96	6	50	50	50
109	6	78	78	78	105	8	72	72	72	78	12	62	62	62
110	3	81	81	81	107	6	78	78	78	79	11	73	73	73
112	9	90	90	90	110	10	88	88	88	81	13	86	86	86
114	10	100	100	100	118	12	100	100	100	89	14	100	100	100
V85 th	83				V85 Th	78				V85 th	81			

Station:33+886														
Passenger cars					Buses					Trucks				
v	f	Fc	fc %	V %	V	f	Fc	Fc %	V %	V	f	Fc	Fc %	V %
96	5	5	5	5	86	3	3	3	3	78	8	8	8	8
100	3	8	8	8	89	5	8	8	8	78	6	14	14	14
103	5	13	13	13	96	5	13	13	13	79	10	24	24	24
103	14	27	27	27	97	9	22	22	22	79	14	38	38	38
109	6	58	58	58	103	6	50	50	50	94	4	69	69	69
110	12	70	70	70	103	13	63	63	63	94	5	74	74	74
111	9	79	79	79	104	8	71	71	71	96	3	77	77	77
112	7	86	86	86	105	9	80	80	80	96	5	82	82	82
112	6	92	92	92	107	10	90	90	90	96	9	91	91	91
114	8	100	100	100	110	10	100	100	100	96	9	100	100	100
V85 th	101				V85 Th	106				V85 th	96			

Station:36+863														
Passenger cars					Buses					Trucks				
v	f	Fc	fc %	V %	V	f	Fc	Fc %	V %	V	f	Fc	Fc %	V %
89	10	10	10	10	78	9	9	9	9	79	7	7	7	7
96	10	20	20	20	89	12	21	21	21	82	12	19	19	19
96	9	29	29	29	89	8	29	29	29	87	9	28	28	28
100	7	36	36	36	89	10	39	39	39	89	10	38	38	38
102	10	46	46	46	94	7	46	46	46	93	10	48	48	48
106	12	58	58	58	96	10	56	56	56	96	10	58	58	58
110	13	71	71	71	96	9	65	65	65	96	9	67	67	67
116	9	80	80	80	102	10	75	75	75	97	8	75	75	75

117	8	88	88	88	110	13	88	88	88	104	12	87	87	87
121	12	100	100	100	118	12	100	100	100	107	13	100	100	100
V85 th	87				V85 th	84				V85 th	85			

Station:37+723														
Passenger cars					Buses					Trucks				
v	f	Fc	fc %	V %	V	f	Fc	Fc %	V %	V	f	Fc	Fc %	V %
102	6	6	6	6	78	6	6	6	6	79	9	9	9	9
108	10	16	16	16	86	8	14	14	14	79	9	18	18	18
100	9	25	25	25	87	6	20	20	20	82	8	26	26	26
96	5	30	30	30	89	6	26	26	26	86	8	34	34	34
110	8	38	38	38	89	7	33	33	33	87	6	40	40	40
96	12	50	50	50	89	6	39	39	39	87	6	46	46	46
110	9	59	59	59	94	9	48	48	48	88	4	50	50	50
117	6	90	90	90	110	9	87	87	87	97	6	83	83	83
121	4	94	94	94	115	4	91	91	91	104	9	92	92	92
116	6	100	100	100	118	9	100	100	100	107	8	100	100	100
V85 th	92				V85 Th	89				V85 th	75			

Station:40+834														
Passenger cars					Buses					Trucks				
v	f	Fc	fc %	V %	V	f	Fc	Fc %	V %	V	f	Fc	Fc %	V %
85	6	6	6	6	85	6	6	6	6	79	9	9	9	9
96	10	16	16	16	89	11	17	17	17	82	12	21	21	21
96	10	26	26	26	94	9	26	26	26	84	8	29	29	29
96	10	36	36	36	96	10	36	36	36	85	8	37	37	37
97	7	43	43	43	96	10	46	46	46	87	8	45	45	45
99	9	52	52	52	96	10	56	56	56	93	10	55	55	55
100	10	62	62	62	97	7	63	63	63	96	10	65	65	65
101	11	73	73	73	100	10	73	73	73	96	10	75	75	75
105	11	84	84	84	102	11	84	84	84	96	10	85	85	85
110	8	92	92	92	110	8	92	92	92	97	7	92	92	92
110	8	100	100	100	110	8	100	100	100	97	8	100	100	100
V85 th	66				V85 th	85				V85 th	96			

Station:43+126														
Passenger cars					Buses					Trucks				
v	f	Fc	fc	V	V	f	Fc	Fc	V	V	f	Fc	Fc	V

			%	%				%	%				%	%
85	6	6	6	6	78	5	5	5	5	79	12	12	12	12
96	10	16	11	11	89	5	10	10	10	82	5	17	17	17
96	11	27	21	21	89	8	18	18	18	82	9	26	26	26
97	9	36	30	30	94	12	30	30	30	85	6	32	32	32
100	12	67	55	55	96	11	57	57	57	93	9	52	52	52
101	5	72	60	60	97	9	66	66	66	93	8	60	60	60
102	9	81	69	69	97	9	75	75	75	96	10	70	70	70
108	8	89	77	77	100	10	85	85	85	96	11	81	81	81
110	6	95	89	89	102	6	91	91	91	97	9	90	90	90
116	5	100	100	100	102	9	100	100	100	97	10	100	100	100
V85 th	79				V85 Th	78				V85 th	84			

Station:44+664														
Passenger cars					Buses					Trucks				
v	f	Fc	fc %	V %	V	f	Fc	Fc %	V %	V	f	Fc	Fc %	V %
85	6	6	5	5	85	6	6	6	6	79	9	9	9	9
96	7	13	12	12	89	7	13	13	13	79	8	17	17	17
96	9	22	24	24	94	14	27	27	27	82	10	27	27	27
96	10	32	31	31	94	8	35	35	35	84	5	32	32	32
96	8	40	41	41	96	7	42	42	42	85	6	38	38	38
97	9	49	50	50	96	9	51	51	51	86	10	48	48	48
99	12	61	58	58	96	10	61	61	61	86	9	57	57	57
100	7	68	68	68	96	8	69	69	69	87	9	66	66	66
100	8	76	77	77	97	9	78	78	78	96	7	73	73	73
104	5	81	85	85	102	8	86	86	86	96	10	83	83	83
109	10	91	94	94	119	5	91	91	91	96	8	91	91	91
110	9	100	100	100	120	9	100	100	100	97	9	100	100	100
V85 th	104			V85 th	102				V85 th	97				

Station:47+594														
Passenger cars					Buses					Trucks				
v	f	Fc	fc %	V %	V	f	Fc	Fc %	V %	V	f	Fc	Fc %	V %
75	9	9	9	9	76	7	7	7	7	77	10	4	4	4
85	6	15	15	15	85	12	19	19	19	79	11	15	15	15
96	13	28	28	28	89	8	27	27	27	82	8	23	23	23
96	11	39	39	39	96	5	32	32	32	84	12	35	35	35
96	8	47	47	47	96	9	41	41	41	85	6	41	41	41
97	6	53	53	53	96	11	52	52	52	86	9	50	50	50
99	10	63	63	63	96	8	60	60	60	87	6	56	56	56

99	5	68	68	68	97	6	66	66	66	96	10	66	66	66
100	8	76	76	76	99	9	75	75	75	96	11	77	77	77
105	6	82	82	82	102	12	87	87	87	96	8	85	85	85
109	7	89	89	89	119	7	94	94	94	97	6	91	91	91
110	11	100	100	100	120	6	100	100	100	97	9	100	100	100
V85 th	108				V85 th	100				V85 th	96			

Station:52+841														
Passenger cars					Buses					Trucks				
v	f	Fc	fc %	V %	V	f	Fc	Fc %	V %	V	f	Fc	Fc %	V %
90	10	10	10	10	89	9	9	9	9	82	12	12	12	12
93	4	14	14	14	89	10	19	19	19	82	8	20	20	20
94	10	24	24	24	94	7	26	26	26	84	10	30	30	30
96	10	34	34	34	96	10	36	36	36	86	5	35	35	35
107	6	75	75	75	102	8	77	77	77	96	9	72	72	72
108	10	85	85	85	107	6	83	83	83	96	10	82	82	82
110	8	93	93	93	119	7	90	90	90	97	9	91	91	91
116	7	100	100	100	120	10	100	100	100	103	9	100	100	100
V85 th	108				V85 Th	110				V85 th	96			

Station:55+431														
Passenger cars					Buses					Trucks				
v	f	Fc	fc %	V %	V	f	Fc	Fc %	V %	V	f	Fc	Fc %	V %
90	10	10	10	10	89	8	8	8	8	75	3	3	3	3
93	9	19	19	19	89	13	21	21	21	76	12	15	15	15
94	12	31	31	31	92	10	31	31	31	82	8	23	23	23
96	13	44	44	44	96	13	44	44	44	82	13	36	36	36
97	10	54	54	54	96	10	54	54	54	84	9	45	45	45
100	8	62	62	62	96	12	66	66	66	89	9	54	54	54
100	13	75	75	75	99	3	69	69	69	93	13	67	67	67
101	13	88	88	88	99	13	82	82	82	96	13	80	80	80
105	3	91	91	91	107	9	91	91	91	96	10	90	90	90
116	9	100	100	100	119	9	100	100	100	98	10	100	100	100
V85 th	100				V85 th	105				V85 Th	96			

Station:57+428		
Passenger cars	Buses	Trucks

v	f	Fc	fc %	V %	V	f	Fc	Fc %	V %	V	f	Fc	Fc %	V %
90	13	13	13	13	89	11	11	11	11	75	10	10	10	10
90	10	23	23	23	89	11	22	22	22	82	11	21	21	21
90	9	32	32	32	94	10	32	32	32	82	11	32	32	32
94	9	41	41	41	96	9	41	41	41	84	8	40	40	40
95	11	52	52	52	96	9	50	50	50	86	9	49	49	49
100	11	63	63	63	99	9	59	59	59	89	10	59	59	59
105	9	72	72	72	99	10	69	69	69	95	10	69	69	69
105	10	82	82	82	107	13	82	82	82	96	9	78	78	78
107	10	92	92	92	107	10	92	92	92	97	9	87	87	87
116	8	100	100	100	119	8	100	100	100	100	13	100	100	100
V_{85} th	106				V_{85} Th	107				V_{85} Th	96			

Station:58+729														
Passenger cars					Buses					Trucks				
v	f	Fc	fc %	V %	V	f	Fc	Fc %	V %	V	f	Fc	Fc %	V %
90	8	13	13	13	89	11	11	11	11	75	10	10	10	10
90	10	23	23	23	89	12	23	23	23	76	11	21	21	21
90	9	32	32	32	94	9	32	32	32	82	12	33	33	33
94	6	38	38	38	96	10	42	42	42	82	6	39	39	39
100	9	47	47	47	99	12	54	54	54	84	10	49	49	49
100	11	58	58	58	99	11	65	65	65	89	9	58	58	58
105	12	70	70	70	107	8	73	73	73	95	11	69	69	69
105	9	79	79	79	107	10	83	83	83	96	10	79	79	79
107	9	88	88	88	107	9	92	92	92	97	12	91	91	91
116	12	100	100	100	119	8	100	100	100	100	9	100	100	100
V85 th	106				V85 th	107				V85 Th	96			

Station:65+056														
Passenger cars					Buses					Trucks				
v	f	Fc	fc %	V %	V	f	Fc	Fc %	V %	V	f	Fc	Fc %	V %
90	13	13	13	13	89	11	11	11	11	82	10	10	10	10
90	10	23	23	23	92	12	23	23	23	84	9	19	19	19
90	13	36	36	36	96	10	33	32	32	89	10	29	29	29
90	10	46	46	46	96	8	41	42	42	93	11	40	40	40
96	11	57	57	57	99	13	54	54	54	96	13	53	53	53
97	9	66	66	66	99	10	64	65	65	96	10	63	63	63
100	9	75	75	75	107	10	74	73	73	96	8	71	71	71

101	2	77	77	77	107	9	83	83	83	97	8	79	79	79
105	11	88	88	88	107	9	92	92	92	98	11	90	90	90
116	12	100	100	100	119	8	100	100	100	100	10	100	100	100
V85 th	105				V85 Th	107				V85 th	97			

Station:72+912														
Passenger cars					Buses					Trucks				
v	f	Fc	fc %	V %	V	f	Fc	Fc %	V %	V	f	Fc	Fc %	V %
89	9	9	9	9	89	14	14	14	14	81	10	10	10	10
90	9	18	18	18	89	10	24	24	24	82	13	23	23	23
90	10	28	28	28	96	11	35	35	35	82	10	33	33	33
90	13	41	41	41	96	10	45	45	45	84	11	44	44	44
93	10	51	51	51	106	12	57	57	57	89	12	56	56	56
100	13	64	64	64	107	13	70	70	70	94	12	68	68	68
105	10	74	74	74	107	10	80	80	80	96	10	78	78	78
116	12	86	86	86	109	11	91	91	91	96	13	91	91	91
118	14	100	100	100	119	9	100	100	100	97	9	100	100	100
V85 th	115				V85 th	108				V85 Th	96			

Station:82+982														
Passenger cars					Buses					Trucks				
v	f	Fc	fc %	V %	V	f	Fc	Fc %	V %	V	f	Fc	Fc %	V %
89	7	7	7	7	89	9	9	9	9	81	5	5	5	5
90	5	12	12	12	89	7	16	16	16	82	9	14	14	14
90	11	23	23	23	92	9	25	25	25	82	7	21	21	21
90	6	29	29	29	96	6	31	31	31	84	10	31	31	31
93	9	38	38	38	96	7	38	38	38	89	9	40	40	40
97	9	47	47	47	99	8	46	46	46	93	8	48	48	48
100	9	56	56	56	106	5	51	51	51	94	7	55	55	55
101	8	64	64	64	107	11	62	62	62	96	11	66	66	66
105	10	74	74	74	107	9	71	71	71	96	6	72	72	72
105	9	83	83	83	109	10	81	81	81	97	10	82	82	82
116	10	93	93	93	109	9	90	90	90	97	9	91	91	91
118	7	100	100	100	119	10	100	100	100	98	9	100	100	100
V85 th	110				V85 th	109				V85 th	97			

Station:120+325		
Passenger cars	Buses	Trucks

v	f	Fc	fc %	V %	V	f	Fc	Fc %	V %	V	f	Fc	Fc %	V %
90	13	13	13	13	89	9	9	9	9	76	11	11	11	11
90	10	23	23	23	89	12	21	21	21	81	10	21	21	21
90	11	34	34	34	96	11	32	32	32	82	9	30	30	30
90	10	44	44	44	96	10	42	42	42	82	13	43	43	43
90	12	56	56	56	106	9	51	51	51	84	12	55	55	55
94	14	70	70	70	107	9	60	60	60	93	10	65	65	65
100	9	79	79	79	107	6	66	66	66	95	9	74	74	74
105	10	89	89	89	107	9	75	75	75	96	11	85	85	85
114	6	95	95	95	113	11	86	86	86	96	10	95	95	95
116	5	100	100	100	119	14	100	100	100	97	5	100	100	100
V85 th	104				V85 th	110				V85 th	96			

Station: 3+431														
Passenger cars					Buses					Trucks				
v	f	Fc	fc %	V %	V	f	Fc	Fc %	V %	V	f	Fc	Fc %	V %
90	9	9	9	9	89	7	7	7	7	75	8	8	8	8
90	9	18	18	18	89	7	14	14	14	76	3	11	11	11
90	8	26	26	26	96	9	23	23	23	76	10	21	21	21
102	7	65	65	65	106	6	65	65	65	85	6	59	59	59
105	8	73	73	73	107	8	73	73	73	86	7	66	66	66
105	9	82	82	82	108	8	81	81	81	93	9	75	75	75
114	7	89	89	89	110	7	88	88	88	94	8	83	83	83
116	9	98	98	98	115	3	91	91	91	96	8	91	91	91
117	2	100	100	100	119	9	100	100	100	97	9	100	100	100
V85 th	110				V85 Th	109				V85 th	95			

Station:5+521														
Passenger cars					Buses					Trucks				
v	f	Fc	fc %	V %	V	f	Fc	Fc %	V %	V	f	Fc	Fc %	V %
90	12	12	12	12	89	10	7	7	7	76	13	8	8	8
90	11	23	23	23	89	13	20	14	14	76	11	19	19	19
93	10	33	33	33	96	11	31	23	23	81	15	34	34	34
95	13	46	46	46	106	12	43	33	33	82	10	44	44	44
100	14	60	60	60	106	10	53	41	41	85	9	53	53	53
102	14	74	74	74	107	14	67	50	50	86	10	63	63	63
105	10	84	84	84	113	9	76	59	59	93	9	72	72	72
117	7	91	91	91	115	10	86	65	65	95	12	84	84	84
117	9	100	100	100	115	14	100	73	73	96	16	100	100	100

V85 th	105	V85 Th	114	V85 th	94

Station:9+203														
Passenger cars					Buses					Trucks				
v	f	Fc	fc %	V %	V	f	Fc	Fc %	V %	V	f	Fc	Fc %	V %
89	10	10	10	10	89	10	10	10	9	75	9	9	9	9
90	7	17	17	17	89	6	16	16	15	76	10	19	19	19
94	11	28	28	28	96	7	23	23	23	76	11	30	30	30
95	7	35	35	35	96	11	34	34	34	81	7	37	37	37
98	8	43	43	43	96	10	44	44	44	82	6	43	43	43
102	6	49	49	49	99	9	53	53	53	84	10	53	53	53
108	8	81	81	81	113	7	83	83	83	96	8	82	82	82
118	9	100	100	100	119	10	100	100	100	98	8	100	100	100
V85 th	115				V85 th	115				V85 th	96			

Station:13+140														
Passenger cars					Buses					Trucks				
v	f	Fc	fc %	V %	V	f	Fc	Fc %	V %	V	f	Fc	Fc %	V %
90	10	10	10	10	89	10	10	10	10	76	10	10	10	10
90	7	17	17	17	96	12	22	22	22	76	14	24	24	24
90	11	28	28	28	96	10	32	32	32	81	9	33	33	33
90	5	33	33	33	96	9	41	41	41	84	11	44	44	44
94	12	45	45	45	106	8	49	49	49	84	13	57	57	57
95	11	56	56	56	107	10	59	59	59	86	4	61	61	61
98	10	66	66	66	107	5	64	64	64	93	9	70	70	70
104	2	68	68	68	108	7	71	71	71	94	7	77	77	77
116	9	77	77	77	115	13	84	84	84	96	10	87	87	87
117	13	90	90	90	119	8	92	92	92	96	8	95	95	95
118	10	100	100	100	119	8	100	100	100	96	5	100	100	100
V85 th	116				V85 th	115				V85 th	96			

Station:18+699														
Passenger cars					Buses					Trucks				
v	f	Fc	fc %	V %	V	f	Fc	Fc %	V %	V	f	Fc	Fc %	V %
89	10	10	10	10	89	10	10	10	10	89	10	10	10	10
96	8	18	18	18	96	8	18	18	18	96	14	24	24	24
100	10	28	28	28	100	9	27	27	27	100	11	35	35	35

100	4	32	32	32	100	10	37	37	37	100	5	40	40	40
102	6	38	38	38	102	8	45	45	45	102	8	48	48	48
104	9	47	47	47	104	9	54	54	54	104	9	57	57	57
110	11	58	58	58	110	4	58	58	58	110	9	66	66	66
113	9	67	67	67	113	9	67	67	67	113	8	74	74	74
115	6	73	73	73	115	12	79	79	79	115	6	80	80	80
115	13	86	86	86	115	7	86	86	86	115	6	86	86	86
117	10	96	96	96	117	10	96	96	96	117	10	96	96	96
118	4	100	100	100	118	4	100	100	100	118	4	100	100	100
V85 th	115				V85 th	115				V85 th	115			

Station:31+631														
Passenger cars					Buses					Trucks				
v	f	Fc	fc %	V %	V	f	Fc	Fc %	V %	V	f	Fc	Fc %	V %
78	10	10	10	10	78	10	10	10	10	78	10	10	10	10
82	3	13	13	13	82	3	13	13	13	82	3	13	13	13
84	10	23	23	23	84	10	23	23	23	84	10	23	23	23
85	11	34	34	34	85	9	32	32	32	85	9	32	32	32
85	6	40	40	40	85	8	40	40	40	85	6	38	38	38
87	9	49	49	49	87	9	49	49	49	87	8	46	46	46
89	5	54	54	54	89	10	59	59	59	89	7	53	53	53
98	4	58	58	58	100	12	71	71	71	100	12	65	65	65
100	12	70	70	70	100	4	75	75	75	100	10	75	75	75
102	11	81	81	81	102	11	86	86	86	102	11	86	86	86
102	9	90	90	90	102	7	93	93	93	102	7	93	93	93
113	10	100	100	100	113	7	100	100	100	113	7	100	100	100
V85 th	115				V85 th	115				V85 th	115			

Station:37+773														
Passenger cars					Buses					Trucks				
v	f	Fc	fc %	V %	V	f	Fc	Fc %	V %	V	f	Fc	Fc %	V %
90	12	12	12	12	87	10	10	10	10	87	10	10	10	10
100	10	22	22	22	89	9	19	19	19	87	11	21	21	21
106	9	31	31	31	89	12	31	31	31	87	8	29	29	29
109	7	38	38	38	102	9	40	40	40	89	10	39	39	39
114	10	48	48	48	109	10	50	50	50	89	11	50	50	50
116	12	60	60	60	116	9	59	59	59	96	9	59	59	59
116	8	68	68	68	118	13	72	72	72	98	9	68	68	68
118	9	77	77	77	119	9	81	81	81	99	12	80	80	80
121	13	90	90	90	120	11	92	92	92	102	10	90	90	90

122	10	100	100	100	120	8	100	100	100	106	10	100	100	100
V85 th	119				V85 th	119				V85 th	100			

Station: 41+494														
Passenger cars					Buses					Trucks				
v	f	Fc	fc %	V %	V	f	Fc	Fc %	V %	V	f	Fc	Fc %	V %
84	4	4	10	10	84	4	4	4	4	84	4	4	4	4
91	6	10	16	16	85	8	12	12	12	85	8	12	12	12
94	8	18	24	24	85	6	18	18	18	85	6	18	18	18
100	5	23	29	29	87	7	25	25	25	87	7	25	25	25
109	7	56	62	62	104	4	58	58	58	104	4	58	58	58
114	10	66	72	72	108	9	67	67	67	108	9	67	67	67
116	7	73	79	79	116	4	71	71	71	116	4	71	71	71
116	8	81	87	87	118	8	79	79	79	118	8	79	79	79
118	6	87	93	93	119	6	85	85	85	119	6	85	85	85
121	9	96	102	102	120	7	92	92	92	120	7	92	92	92
122	4	100	100	100	120	8	100	100	100	120	8	100	100	100
V85 th	118				V85 th	119				V85 th	119			

Station: 52+421														
Passenger cars					Buses					Trucks				
v	f	Fc	fc %	V %	V	f	Fc	Fc %	V %	V	f	Fc	Fc %	V %
94	8	8	8	8	85	10	10	10	10	85	11	11	11	11
100	13	21	21	21	87	9	19	19	19	87	9	20	20	20
106	10	31	31	31	89	11	30	30	30	87	10	30	30	30
106	9	40	40	40	101	12	42	42	42	87	8	38	38	38
114	9	49	49	49	101	9	51	51	51	89	12	50	50	50
114	11	60	60	60	108	13	64	64	64	96	9	59	59	59
116	9	69	69	69	108	9	73	73	73	96	10	69	69	69
121	9	78	78	78	116	8	81	81	81	98	11	80	80	80
122	12	90	90	90	116	12	93	93	93	102	11	91	91	91
122	10	100	100	100	120	7	100	100	100	102	9	100	100	100
V85 th	121				V85 th	116				V85 th	100			

Station:62+007														
Passenger cars					Buses					Trucks				
v	f	Fc	fc %	V %	V	f	Fc	Fc %	V %	V	f	Fc	Fc %	V %

84	5	11	11	11	84	10	10	10	10	84	10	10	10	10
91	6	17	17	17	85	12	22	22	22	85	8	18	18	18
94	8	25	25	25	85	8	30	30	30	85	9	27	27	27
100	9	34	34	34	87	7	37	37	37	87	10	37	37	37
104	12	46	46	46	89	11	48	48	48	87	10	47	47	47
105	7	53	53	53	99	6	54	54	54	87	8	55	55	55
106	11	64	64	64	101	6	60	60	60	89	12	67	67	67
106	6	70	70	70	102	7	67	67	67	89	4	71	71	71
109	9	79	79	79	104	9	76	76	76	96	8	79	79	79
112	10	89	89	89	104	8	84	84	84	102	6	85	85	85
116	7	96	96	96	116	9	93	93	93	102	7	92	92	92
122	4	100	100	100	116	7	100	100	100	110	8	100	100	100
V85 th	110				V85 th	104				V85 th	86			

Station:81+374														
Passenger cars					Buses					Trucks				
v	f	Fc	fc %	V %	V	f	Fc	Fc %	V %	V	f	Fc	Fc %	V %
78	11	11	11	11	78	10	10	10	10	10	10	10	10	10
82	8	19	19	19	82	8	18	18	22	18	7	17	17	17
84	10	29	29	29	84	9	27	27	30	27	13	30	30	30
85	9	38	38	38	85	6	33	33	37	33	10	40	40	40
85	12	50	50	50	85	12	45	45	48	45	8	48	48	48
95	10	60	60	60	95	10	55	55	54	55	9	57	57	57
102	7	67	67	67	96	8	63	63	60	63	7	64	64	64
106	10	77	77	77	100	9	72	72	67	72	9	73	73	73
107	5	82	82	82	102	8	80	80	76	80	8	81	81	81
108	8	90	90	90	102	10	90	90	84	90	8	89	89	89
109	10	100	100	100	102	10	100	100	93	100	11	100	100	100
V85 th	107				V85 th	102				V85 th	79			

Station:83+072														
Passenger cars					Buses					Trucks				
v	f	Fc	fc %	V %	V	f	Fc	Fc %	V %	V	f	Fc	Fc %	V %
78	4	4	4	4	78	7	4	4	4	78	9	9	9	9
82	8	12	12	12	82	11	15	15	15	82	8	17	17	17
84	5	17	17	17	84	8	23	23	23	83	7	24	24	24
85	4	21	21	21	85	6	29	29	29	84	5	29	29	29
85	6	27	27	27	85	7	36	36	36	85	4	33	33	33
85	12	39	39	39	85	10	46	46	46	85	6	39	39	39

87	6	45	45	45	87	5	51	51	51	85	7	46	46	46
89	11	56	56	56	89	5	56	56	56	87	8	54	54	54
95	10	66	66	66	95	5	61	61	61	87	7	61	61	61
98	4	70	70	70	96	12	73	73	73	89	10	71	71	71
102	7	77	77	77	100	10	83	83	83	95	10	81	81	81
106	10	87	87	87	100	7	90	90	90	96	8	89	89	89
107	5	92	92	92	102	4	94	94	94	99	4	93	93	93
108	8	100	100	100	102	6	100	100	100	102	7	100	100	100
V85 th	106				V85 th	76				V85 th	79			

Station:102+404														
Passenger cars					Buses					Trucks				
v	f	Fc	fc %	V %	V	f	Fc	Fc %	V %	V	f	Fc	Fc %	V %
78	8	8	8	8	78	8	8	8	8	78	8	8	8	8
82	6	14	14	14	82	6	14	14	14	79	9	17	17	17
95	11	54	54	54	95	11	55	55	55	89	5	52	52	52
96	10	64	64	64	96	10	65	65	65	89	7	59	59	59
102	11	75	75	75	102	10	75	75	75	95	11	70	70	70
115	6	81	81	81	115	6	81	81	81	96	10	80	80	80
117	5	86	86	86	117	5	86	86	86	96	5	85	85	85
118	9	95	95	95	118	9	95	95	95	102	9	94	94	94
121	5	100	100	100	121	5	100	100	100	102	6	100	100	100
V85 th	86				V85 th	84				V85 th	76			

Station:122+634														
Passenger cars					Buses					Trucks				
v	f	Fc	fc %	V %	V	f	Fc	Fc %	V %	V	f	Fc	Fc %	V %
78	8	8	8	8	78	8	8	8	8	78	9	9	9	9
85	13	21	21	21	82	11	19	19	19	79	10	19	19	19
95	3	24	24	24	82	10	29	29	29	82	8	27	27	27
96	8	32	32	32	85	9	38	38	38	82	11	38	38	38
102	10	42	42	42	89	12	50	50	50	85	13	51	51	51
105	9	51	51	51	89	10	60	60	60	85	7	58	58	58
106	8	59	59	59	95	9	69	69	69	89	6	64	64	64
106	11	70	70	70	96	13	82	82	82	89	10	74	74	74
114	12	82	82	82	106	5	87	87	87	89	12	86	86	86
120	10	92	92	92	107	4	91	91	91	95	6	92	92	92
120	8	100	100	100	113	9	100	100	100	96	8	100	100	100
V85 th	115				V85 th	100				V85 th	89			

Station:123+384														
Passenger cars					Buses					Trucks				
v	f	Fc	fc %	V %	V	f	Fc	Fc %	V %	V	f	Fc	Fc %	V %
78	8	8	8	8	78	8	8	8	8	78	9	9	9	9
85	9	17	17	17	82	11	19	19	19	79	11	20	20	20
95	13	30	30	30	85	8	27	27	27	82	8	28	28	28
96	8	38	38	38	89	15	42	42	42	84	9	37	37	37
100	10	48	48	48	95	7	49	49	49	85	10	47	47	47
102	6	54	54	54	96	8	57	57	57	85	7	54	54	54
105	4	58	58	58	106	9	66	66	66	89	6	60	60	60
106	8	66	66	66	107	10	76	76	76	89	13	73	73	73
107	9	75	75	75	113	4	80	80	80	95	11	84	84	84
113	10	85	85	85	113	11	91	91	91	96	8	92	92	92
120	15	100	100	100	115	9	100	100	100	101	8	100	100	100
V85 th	93				V85 th	83				V85 th	85			

Station:127+251														
Passenger cars					Buses					Trucks				
v	f	Fc	fc %	V %	V	f	Fc	Fc %	V %	V	f	Fc	Fc %	V %
85	8	8	8	8	85	8	8	8	8	85	9	9	9	9
95	12	20	20	20	95	13	21	21	21	86	11	20	20	20
96	11	31	31	31	96	11	32	32	32	89	10	30	30	30
100	8	39	39	39	100	10	42	42	42	89	9	39	39	39
103	8	47	47	47	100	8	50	50	50	95	8	47	47	47
107	13	60	60	60	102	11	61	61	61	96	11	58	58	58
110	4	64	64	64	103	9	70	70	70	97	12	70	70	70
112	10	74	74	74	107	8	78	78	78	98	5	75	75	75
113	5	79	79	79	112	4	82	82	82	99	8	83	83	83
115	10	89	89	89	113	10	92	92	92	113	10	93	93	93
121	11	100	100	100	115	8	100	100	100	115	7	100	100	100
V85 th	104				V85 th	103				V85 th	100			

Station:128+986														
Passenger cars					Buses					Trucks				
v	f	Fc	fc %	V %	V	f	Fc	Fc %	V %	V	f	Fc	Fc %	V %
85	8	8	8	8	85	8	8	8	8	97	9	9	9	9
100	11	19	19	19	89	8	16	16	16	98	10	19	19	19

102	8	27	27	27	100	8	24	24	24	99	9	28	28	28
103	6	33	33	33	100	9	33	33	33	89	11	39	39	39
105	9	42	42	42	100	10	43	43	43	107	7	46	46	46
107	5	47	47	47	102	7	50	50	50	85	10	56	56	56
112	9	56	56	56	102	8	58	58	58	110	7	63	63	63
117	7	63	63	63	107	11	69	69	69	98	9	72	72	72
118	9	72	72	72	112	6	75	75	75	104	6	78	78	78
121	8	80	80	80	117	10	85	85	85	89	4	82	82	82
121	10	90	90	90	118	9	94	94	94	102	8	90	90	90
121	10	100	100	100	121	6	100	100	100	98	10	100	100	100
V85 th	78				V85 th	77				V85 th	76			

Station:130+988														
Passenger cars					Buses					Trucks				
v	f	Fc	fc %	V %	V	f	Fc	Fc %	V %	V	f	Fc	Fc %	V %
85	8	8	8	8	85	4	4	4	4	85	4	4	4	4
95	10	18	18	18	89	13	17	17	17	89	4	8	8	8
96	6	24	24	24	95	10	27	27	27	89	13	21	21	21
100	11	35	35	35	96	6	33	33	33	95	10	31	31	31
102	8	43	43	43	100	9	42	42	42	96	6	37	37	37
105	13	56	56	56	100	11	53	53	53	98	10	47	47	47
107	7	63	63	63	102	10	63	63	63	99	11	58	58	58
112	4	67	67	67	107	7	70	70	70	102	11	69	69	69
113	10	77	77	77	112	6	76	76	76	104	6	75	75	75
115	8	85	85	85	113	10	86	86	86	107	7	82	82	82
121	9	94	94	94	115	8	94	94	94	113	10	92	92	92
121	6	100	100	100	121	6	100	100	100	115	8	100	100	100
V85 th	87				V85 th	85				V85 th	79			

Station:143+165														
Passenger cars					Buses					Trucks				
v	f	Fc	fc %	V %	V	f	Fc	Fc %	V %	V	f	Fc	Fc %	V %
78	8	8	8	8	78	8	8	8	8	78	9	9	9	9
85	9	17	17	17	82	11	19	19	19	79	11	20	20	20
95	13	30	30	30	85	8	27	27	27	82	8	28	28	28
96	8	38	38	38	89	15	42	42	42	84	9	37	37	37
100	10	48	48	48	95	7	49	49	49	85	10	47	47	47
102	6	54	54	54	96	8	57	57	57	85	7	54	54	54
105	4	58	58	58	106	9	66	66	66	89	6	60	60	60

106	8	66	66	66	107	10	76	76	76	89	13	73	73	73
107	9	75	75	75	113	4	80	80	80	95	11	84	84	84
113	10	85	85	85	113	11	91	91	91	96	8	92	92	92
120	15	100	100	100	115	9	100	100	100	101	8	100	100	100
V85 th	97				V85 th	87				V85 th	86			

Appendix C

C1. REGRESSION ANALYSIS FOR HORIZONTAL CIRCULAR CURVE

Descriptive Statistics

	Mean	Std. Deviation	N
Operating Speed (km/h)	121.44	16.764	45
Radius(m)	484.47	213.886	45
Total Pavement Width (m)	10.81	1.948	45
Grade (%)	1.54	1.151	45
Super elevation (m/m0	5.14	1.760	45
Curve Length (m)	258.20	198.577	45

Correlations

		Operating Speed (km/h)	Radius(m)	Total Pavement Width (m)	Grade (%)	Super elevation (m/m)	Curve Length (m)
Pearson Correlation	Operating Speed (km/h)	1.000	.188	-.028	-.543	-.390	.264
	Radius(m)	.188	1.000	.229	-.058	-.454	-.104
	Total Pavement Width (m)	-.028	.229	1.000	.053	-.365	.011
	Grade (%)	-.543	-.058	.053	1.000	.169	-.268
	Super elevation (m/m0	-.390	-.454	-.365	.169	1.000	-.167
	Curve Length (m)	.264	-.104	.011	-.268	-.167	1.000

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
	.641	.411	.335	13.669	.411	5.435	5	39	.001

ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	5077.991	5	1015.598	5.435	.001
	Residual	7287.120	39	186.849		
	Total	12365.111	44			

Coefficients

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B		Collinearity Statistics	
	B	Std. Error	Beta			Lower Bound	Upper Bound	Tolerance	VIF
(Constant)	155.57	18.597		8.365	.000	117.954	193.185		
Radius(m)	.005	.011	.058	.407	.686	-.018	.027	.756	1.322
Total Pavement Width (m)	-1.166	1.148	-.135	-1.015	.316	-3.489	1.157	.849	1.179
Grade (%)	-6.586	1.889	-.452	-3.487	.001	-10.407	-2.765	.899	1.113
Super elevation (m/m)	-3.054	1.433	-.321	-2.132	.039	-5.952	-.156	.668	1.497
Curve Length (m)	.008	.011	.097	.738	.465	-.014	.031	.874	1.144

C2. REGRESSION ANALYSIS FOR HORIZONTAL TANGENT SECTION

Descriptive Statistics

	Mean	Std. Deviation	N
Operating Speed (km/h)	120.84	13.242	45
Tangent Length (m)	1065.18	931.996	45
Total Pavement Width (m)	10.68	2.138	45
Grade (%)	1.58	1.233	45

Correlations

		Operating Speed (km/h)	Tangent Length (m)	Total Pavement Width (m)	Grade (%)
Pearson Correlation	Operating Speed (km/h)	1.000	.228	-.237	-.284
	Tangent Length (m)	.228	1.000	-.015	-.299
	Total Pavement Width (m)	-.237	-.015	1.000	.092
	Grade (%)	-.284	-.299	.092	1.000
Sig. (1-tailed)	Operating Speed (km/h)	.	.066	.058	.029
	Tangent Length (m)	.066	.	.460	.023
	Total Pavement Width (m)	.058	.460	.	.273
	Grade (%)	.029	.023	.273	.

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
	.532	.149	.087	12.655	.149	2.393	3	41	.082

ANOVA

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	1149.736	3	383.245	2.393	.082
Residual	6566.176	41	160.151		
Total	7715.911	44			

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B		Collinearity Statistics	
	B	Std. Error	Beta			Lower Bound	Upper Bound	Tolerance	VIF
Constant	136.316	10.269		13.274	0	115.576	157.055		
Total pavement Width (m)	0.002	0.002	0.16	1.059	0.296	-0.002	0.007	0.91	1.1
Tangent Length (m)	-1.331	0.896	-0.215	-1.485	0.145	-3.14	0.479		1.01
Grade (%)	-2.326	1.629	-0.217	-1.428	0.161	-5.615	0.963		0.99

Operating speed characteristics on tangents											
Cars				Buses				Trucks			
Avg	Std	Var	V85th	Avg	Std	Var	V85th	Avg	Std	Var	V85th
89	12	576	125	89	12	576	125	89	12	576	125
100	13	546	130	100	13	546	130	100	13	546	130
110	25	456	130	110	25	456	130	110	25	456	130
99	26	256	125	99	26	256	125	99	26	256	125
98	21	230	112	98	21	230	112	98	21	230	112
89	14	254	99	89	14	254	99	89	14	254	99
116	17	200	121	116	17	200	121	116	17	200	121
115	18	251	118	115	18	320	118	115	18	250	118
114	17	325	116	114	17	325	116	114	17	325	116
100	16	412	109	100	16	412	109	100	16	412	109
96	18	450	125	96	18	450	125	96	18	450	125
89	21	421	131	89	21	421	131	89	21	421	131
92	23	510	117	92	23	510	117	92	23	510	117
91	22	412	116	91	22	412	116	91	22	412	116
93	19	420	115	93	19	420	115	93	19	420	115
97	15	562	89	97	15	562	89	97	15	562	89
97	4	623	99	97	4	623	99	97	4	623	99
98	18	560	124	98	18	560	124	98	18	560	124
91	14	289	108	91	14	289	108	91	14	289	108
111	16	278	106	111	16	278	106	111	16	278	106
110	23	510	114	110	23	510	114	110	23	510	114
120	25	451	113	120	25	451	113	120	25	451	113
87	24	231	120	87	24	231	120	87	24	231	120
96	26	365	106	96	26	365	106	96	26	365	106

89	2	304	100	89	2	304	100	89	2	304	100
121	28	576	114	121	28	576	114	121	28	576	114
108	21	421	99	108	21	421	99	108	21	421	99
114	27	586	121	114	27	586	121	114	27	586	121
113	22	442	116	113	22	442	116	113	22	442	116
112	22	236	124	112	22	236	124	112	22	236	124
100	23	256	118	100	23	256	118	100	23	256	118
99	24	241	116	99	24	241	116	99	24	241	116
102	23	289	109	102	23	289	109	102	23	289	109
102	24	540	113	102	24	540	113	102	24	540	113
79	25	530	89	79	25	530	89	79	25	530	89
103	26	481	123	103	26	481	123	103	26	481	123
102	23	526	115	102	23	526	115	102	23	526	115
95	21	430	95	95	21	430	95	95	21	430	95
87	20	452	114	87	20	452	114	87	20	452	114
98	20	602	102	98	20	602	102	98	20	602	102
86	23	562	113	86	23	562	113	86	23	562	113
89	27	531	120	89	27	531	120	89	27	531	120

Operating speed characteristics on curves											
Cars				Buses				Trucks			
Avg	Std	Var	V85th	Avg	Std	Var	V85th	Avg	Std	Var	V85th
89	12	576	125	89	12	576	125	89	12	576	113
100	13	546	130	100	13	546	130	100	13	546	115
110	25	456	130	110	25	456	130	110	25	456	104
99	26	256	125	99	26	256	125	99	26	256	110
98	21	230	112	98	21	230	112	98	21	230	117
89	14	254	99	89	14	254	99	89	14	254	106
116	17	200	121	116	17	200	121	116	17	200	127
115	18	0	118	115	18	0	118	115	18	0	109
114	17	325	116	114	17	325	116	114	17	325	110
100	16	412	109	100	16	412	109	100	16	412	109
96	18	450	125	96	18	450	125	96	18	450	110
89	21	421	131	89	21	421	131	89	21	421	112
92	23	510	117	92	23	510	117	92	23	510	116
91	22	412	116	91	22	412	116	91	22	412	127
93	19	420	115	93	19	420	115	93	19	420	105
97	15	562	89	97	15	562	89	97	15	562	127
97	4	623	99	97	4	623	99	97	4	623	104
98	18	560	124	98	18	560	124	98	18	560	108
91	14	289	108	91	14	289	108	91	14	289	110
111	16	278	106	111	16	278	106	111	16	278	105
110	23	510	114	110	23	510	114	110	23	510	106

120	25	451	113	120	25	451	113	120	25	451	107
87	24	231	120	87	24	231	120	87	24	231	105
96	26	365	106	96	26	365	106	96	26	365	115
89	2	304	100	89	2	304	100	89	2	304	110
121	28	576	114	121	28	576	114	121	28	576	110
108	21	421	99	108	21	421	99	108	21	421	110
114	27	586	121	114	27	586	121	114	27	586	114
113	22	442	116	113	22	442	116	113	22	442	115
112	22	236	124	112	22	236	124	112	22	236	116
100	23	256	118	100	23	256	118	100	23	256	115
99	24	241	116	99	24	241	116	99	24	241	115
102	23	289	109	102	23	289	109	102	23	289	119
102	24	540	113	102	24	540	113	102	24	540	119
79	25	530	89	79	25	530	89	79	25	530	121
103	26	481	123	103	26	481	123	103	26	481	110
102	23	526	115	102	23	526	115	102	23	526	107
95	21	430	95	95	21	430	95	95	21	430	125
87	20	452	114	87	20	452	114	87	20	452	116
98	20	602	102	98	20	602	102	98	20	602	115
86	23	562	113	86	23	562	113	86	23	562	113
89	27	531	120	89	27	531	120	89	27	531	113